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THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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PRELIMINARY WORK ON THE PANAMA CANAL.

By John F. Wallace.

In this, Mr. Wallace's second paper upon the subject, we have a concise statement of facts which clearly reveal the chaotic condition of affairs on the Isthmus in the spring of 1904, when the Canal Commission took over the property rights and dilapidated equipment of the old French company. No systematic organization, no adequate water supply, no tolerable sewerage system, the quarters for workmen falling into ruins, the mechanical equipment antiquated or practically useless, governmental "red-tape" obstructing the engineers at every step, and even the plan of the canal yet in debate—verily, under such conditions it is remarkable that so much important preliminary work was accomplished. It is only by studying the subject as a whole and in detail that a clear grasp of the great work can be obtained; and it will be through a perusal of the preceding paper, as well as those which are to follow, that the magnitude of the problem can be appreciated. —THE EDITORS.

THE nine eminent engineers carefully selected by President McKinley, from the army, navy and civil life, who composed the first Walker Commission, and whose consideration of the Canal project extended over the greater part of three years—1899 to 1901 inclusive—estimated that it would cost approximately, $144,000,000, and require ten years (of which two years was held as necessary for the preparatory work) to complete the Isthmian canal on the Panama route, according to the general plan outlined in the report of the commission; the controlling factor as to time in all the Panama projects being the removal of material from the summit excavation at Culebra.

The total amount of material to be excavated and the incidental work connected therewith, for the construction of the canal on a ninety-foot level, in round numbers is 100,000,000 cubic yards—one-half of which, or, approximately 50,000,000 cubic yards, being contained within the distance of the ten miles embracing the summit cut.

With the single exception of Bohio dam, where the estimate and views of the commission seemed to have been based on insufficient facts, the estimates as to the time and cost appeared to have been well-considered and conservative. It was certainly reasonable to expect that two years should be occupied in preparation for a work of this magnitude and character, even if the general features of the plan had been decided upon.

If the second Walker Commission had considered its functions confined to the construction of a high-level canal as outlined in the report of the first Walker Commission, and as provided for by the Spooner act, and if the various elements of this plan had been fully considered and determined upon to such an extent as to have justified the existing commission in confining itself simply to the execution of a well-considered and settled general plan—then the situation would have been much simplified, and the sequence of organization, preparation and execution would have been substantially as follows:

The organization would include, first, the governmental machinery necessary for the control of the population contained in the Canal Zone; this embracing all of the governmental functions—legislative, judicatory, and executive, providing for the necessary sub-departments, i. e., public schools; courts, civil and penal; police; sanitation and public health; postal; revenue; treasury and accounting departments; and the controlling, collection and disbursement of the government revenues—in fact a complete governmental organization in every detail on a small scale.

The second division of the organization would be that of the engineering department; not, however, along a narrow technical line, but considering that this department would be eventually charged with the administration and execution of all matters connected with the construction of the canal on the Isthmus, except those of a purely governmental nature.

The preparation would consist, first, in the work of sanitation, including a general organization scheme for this department in all its details: Personnel; plans for the repairing and construction of hospitals; devising, and enforcing by proper police regulations, the cleaning of cities, towns and settlements; the drainage of swamps, removal of vegetation; sewerage and water supply for the cities, towns and settlements: and all other sundry preparatory work tending to eliminate causes of disease.

The preparatory work would next consist in the provision of suitable quarters and accommodations, commissary facilities, means of diversion, and other sundry arrangements for the care of the governmental, sanitary, engineering, and construction employes and their dependents; and should consider the necessity of importing almost the entire personnel of the force from a temperate zone, 2,000 miles away, and bring it into an enervating, unhealthful tropical climate.

The importance of the proper treatment of this question cannot be over-estimated; as the basis of efficient and economical results in any organization depends upon the contentment and willing efforts of its personnel.

The third part of the preparation would be the making of surveys and the securing of data for the prosecution of the technical studies, and the preparation of detail plans and specifications necessary for the after-accomplishment of the work, whether it be effected by hired labor or by contract, in whole or in part, as might be afterwards determined.

The fourth feature of the preparatory operations would be the gradual building up of a permanent organization for the administration and execution of the engineering and construction work.

It is evident that this scheme of organization and preparation could not be fully or properly accomplished until the important basic questions of plan and policy had been decided upon.

Various practical considerations made it necessary that, in order to accomplish the best results, these various items of organization and preparation should be carried on simultaneously. Suitable quarters and accommodations could not be provided without organization, supervision, plans and material, which of course, rendered a large force necessary almost at the commencement of the work, which had to be provided with suitable quarters and accommodations.

The installing of sewerage and water supplies in the various town and settlements could not be made without technical studies, plans and specifications, which necessitated the employment of a force for that purpose.

Again, a certain force was also necessary for governmental and executive purposes, embracing not only the office force, but employes of many classes. It was necessary to have a nucleus force of this kind practically from the inception of the work of organization and preparation.

Sanitary arrangements, hospital care, quarters and other accommodations had to be provided for this initial force.

It would seem apparent that the work of organization and preparation must necessarily be one of gradual growth, and, considering the fact that practically all of the persons sent to the Isthmus were unfamiliar with the local conditions, that a large amount of dissatisfaction and discontent would be present among the employes, and the relation of the forces in the various departments and sub-departments would be continually out of balance, until a sufficient time had elapsed to create an experienced, well-seasoned organization. Underlying conditions suggest that this accomplishment would be impossible in a single month or a single year.

At Panama the situation was still further complicated, however, by the fact that the construction work was already being carried on by what was known as the French New Panama Canal Company. While the construction organization was not large or particularly efficient, it was considered the part of wisdom by all, that it should be continued and used as a nucleus for the larger organization to follow. This course was advisable for the reason that a certain amount of excavation could be made regardless of which plan should be finally determined upon.

The persons at the head of the sanitary department were confident of their ability to practically eliminate yellow fever, and reduce and keep within reasonable control the other diseases peculiar to the Isthmian climate.

Over and above all, however, the apparent impatient and undue anxiety of the American people to see "the dirt fly," as expressed through the columns of the press, induced the administration, through the commission, to put forth every effort to secure an early accomplishment.

Immediately after the appointment of the writer as Chief Engineer in June, 1904, he proceeded to Washington for conference with the commission, which resulted in its being considered advisable for him to promptly depart for the Isthmus to make a careful study of the actual conditions from direct personal observation, in order to determine the character and extent of the organization necessary to prosecute the preparatory work.

In company with Col. Gorgas, the chief of the sanitary department, the writer sailed for the Isthmus and arrived at Panama on June 28, 1904, reporting his arrival to General George B. Davis, Governor of the Canal Zone and Isthmian Canal Commissioner, to whom the commission had previously delegated the general supervision of the engineering and construction work—which was under the immediate charge of Major W. M. Black of the United States Engineers—pending the arrival of the Chief Engineer.

After conference with General George B. Davis, who was acting as managing representative of the Isthmian Canal Commission under the powers delegated to him, the engineering work was transferred to the control of the writer, who actively entered on his duties on July 1, 1904, relieving Major Black, who had been recalled to the United States to resume his regular duties in the Corps of Engineers, U. S. A.

The situation of the Government work and sanitation on the Isthmus July 1, 1905, was as follows: General George B. Davis, as Governor of the Canal Zone, had procured in a preliminary way, the organization of the various departments necessary for the conduct of the governmental zone, and had arranged with the Republic of Panama the tentative delimitation of the Canal Zone, and of the boundaries of the cities of Panama and Colon, which, while inside of the general territorial limits of the Zone boundaries, constituted practically governmental islands belonging to the Republic of Panama, and were retained as part of the territory of that government under the terms of the treaty existing between the United States and the Republic of Panama.

Col. Gorgas, the chief sanitary officer, had also commenced the organization of his department and had taken possession of the former French hospitals situated at Ancon and Colon.

The status of the engineering and construction work was as follows: A corps of engineers under Mr. Charles List, had been placed in charge of surveys, technical studies and other engineering work in the vicinity of Colon, with instructions to secure data and make such examinations and studies as would be necessary to determine the proper treatment of the harbor of Colon, the location of the entrance of the Canal, and the necessary diversion channels between Colon and Gatun, with instructions to make such surveys and borings as would determine the physical characteristics, topography of the ground, and also the sub-formation of the Chagres valley between these points.

Mr. A. B. Nichols with a corps of engineers was situated at Gatun, with instructions to make a thorough study to determine the proper location of the canal and the necessary diversion channels between Gatun and Bohio, and in particular to make such surveys and borings as would determine the physical characteristics and topography of the ground, and the sub-formation of the Chagres valley between these points in order to ascertain the possibility of the location of a dam in the general vicinity of Gatun, as suggested by Mr. Ward in his paper before the American Society of Civil Engineers.

He was also to study the merits of what was known as the "Tiger Hill Cut-off" as compared with the French location of the canal axis between Bohio and Gatun, the "Tiger Hill Cut-off" having been suggested as an alternate proposition.

Mr. H. F. Dose, with the engineering force under his direction, was assigned to the duty of investigating the physical characteristics of the Chagres valley between Bohio and Bas Obispo, with particular instructions to investigate, by diamond-drill borings, the sub-formation in the vicinity of Bohio, obtaining accurate detail information as to the practicability of a dam in that locality, which, under the plan of the former commission, would create the artificial lake "Bohio," forming the summit-level of the canal at an elevation varying from eighty-five to ninety feet above the sea-level.

Mr. Boyd Ehle, with the engineering force under his direction, was assigned to the duty of conducting the necessary investigations for determining the physical characteristics of the Chagres valley above Bas Obispo, including the hydraulic problems connected with the control of the Chagres river, with special instructions to investigate the practicability of the Gamboa dam site; the accurate determination of the water-shed which would be tributary to that dam; and to make such diamond-drill borings and topographical surveys at that locality as would furnish data and fully decide this question.

Mr. Ehle was further instructed to make such explorations and surveys as would determine the possibility of obtaining a spill-way through the continental divide, into the head waters of the Juan Diaz, thus enabling the surplus waters contained by the Gamboa dam to be discharged onto the Pacific slope; or, the practicability of a spill-way for directing this water onto the Caribbean slope.

It was also his duty to procure the data to determine the possibility —through the construction of a dam at Gamboa or other auxiliary works—of discharging the regulated flow of the Chagres river into the canal prism proper, or through diversion channels parallel to that prism.

Mr. A. C. Harper, as resident engineer, was in charge of the construction work which had previously been carried on under the new French Canal Company at Culebra; and he also had charge of such temporary and immediate repairs as it was necessary to make in order to provide habitable quarters for the preliminary organization of the various departments.

To Mr. C. F. Bertoncini, a former employe of the French Canal Company, and who had been retained as chief draftsman, was given charge of all the engineering records and of the drafting department at the general office in Panama.

Mr. E. C. Toby, a disbursing officer of the United States Navy Department, acted under the direction of General George B. Davis, and had charge of the accounting work on the Isthmus, besides the custody of material and supplies. In addition to these he had other special duties which he was called upon to perform by General Davis.

The writer has not at hand the data to give the total number of the force employed as of July 1, 1904. It is sufficient, however, for the purpose of this paper, to state that it consisted of approximately 1,000 men, which included about 500 natives of the Isthmus, adjoining countries and the West Indies, who were engaged in the construction work; and possibly 500 men of English, American, French, and Spanish nativity, who were employed in the governmental, sanitary and engineering departments. At this time, also, every steamship was bringing fresh employes to the Isthmus, and a few were returning. The mechanical and laboring forces therefore varied largely from day to day, owing to the irregular and spasmodic habits of these classes in a tropical country.

The force and tentative organization thus outlined was that in effect July 1, 1904. No material progress had been made with the surveys and technical studies, prior to July 1, on account of the delay in the shipment of material and supplies to the various engineering parties in the field. Also, owing to the shortage of material and the scarcity of *skilled* labor, only insignificant repairs had been made to the buildings—about 2,500 in number—erected by the original French company, which were in a condition of more or less dilapidation and ill-repair.

As to the construction work, the French records show that during the four years preceding the 1st of June, 1904, approximately 57,000 cubic yards of material per month had been removed from the Culebra cut. This material, however, had been roughly estimated by Jamaica negroes, to whom was assigned this duty, and who practically guessed at the contents of the loose material loaded into the cars, which were often only partially filled. Although the French engineers had very carefully determined the ratio of the solid measurement to the loose material in the cars, the cars were not uniformly loaded, and as the ratio evidently varied also with the character of material loaded, this seeming accuracy was somewhat misleading. Estimates were not made from measured cross-sections.

Again, a portion of this material was deposited upon the spoil-banks inside of the cross section of the probable ultimate excavation. During the ten months previous to American control, this average output had been reduced to approximately 25,000 cubic yards per month. These figures are approximations arrived at from the data contained in the report made by Major Black, as the result of his observations and investigations of the methods and measurements employed during his period of residence on the Isthmus. The falling off of the output had evidently been brought about by the desire of the French company to spend the minimum amount of money, pending the time when the work would be finally transferred to the control of the United States.*

Prior to the arrival of General George B. Davis upon the Isthmus, May 17, 1904, the entire line of the canal, with the exception of the Culebra excavation, was covered with a dense jungle, and machinery and supplies were scattered along the route of the canal as they were left at the collapse of the old Isthmian Canal Company, when the work was finally suspended by the liquidator on the 15th day of May, 1889, fifteen years previously.

Such material and supplies, however, as were stored in the warehouses of the canal company under the charge of the material and supply department, and unissued, were in fairly good condition, and were systematically stored, arranged, tabulated, and properly cared for; thus contrasting strongly with the condition of the machinery and material issued to the agents and contractors distributed over the line of the work.

Prior to the arrival of the Chief Engineer on the Isthmus Mr. Charles A. Strom had been engaged as a mechanical engineer, and in connection with a Commissioner, Mr. Frank J. Hecker, commenced a systematic examination into the condition and efficiency of the machinery and supplies above mentioned, the original cost of which, as charged on the books of the French company, approximated $29,000,000.

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* In this connection the writer desires to state that much interesting matter containing the results of Major Black's observations and examinations during the period in which he had charge of the work on the Isthmus is to be found in a series of reports made to Admiral Walker, Chairman of the Commission, and which, while on file in the office of the Panama Canal Commission, were not officially published. The writer, however, had a few copies of these reports printed at Panama for the benefit of his staff.

During the fifteen years that had elapsed since the work had been abandoned by the liquidator of the original French company and the formation of the new company, no particular attention had been paid to sanitation on the Isthmus and at Colon, or along the line of the work. While the death rate had been lowered as compared with the situation during the De Lesseps' régime, this was due to the fact that the resident population had become more or less immune, and that fresh material had not been supplied for the yellow fever and other malignant Isthmian diseases to feed upon.

Owing to the constant flow of South and Central American travel through the Isthmian gateway to and from other infected points, it was obvious to the Commission that the first step was to properly sanitate the cities of Panama and Colon, and secondarily the Canal Zone; and afterwards, by the rigid enforcement of a quarantine to prevent the admission of new infection.

As a primary condition to successful sanitation, pure water and adequate sewerage systems are indispensable; and before setting sail for the Isthmus, the writer secured the services of Mr. Carleton E. Davis as engineer of sewerage and water-supply, instructions being given him to organize his force and proceed to the Isthmus at the earliest possible date.

Prior to the arrival of Mr. Davis, the writer made a careful study of the various proposed systems of water supply for the city of Panama, which had heretofore been under consideration. At the suggestion of General Davis, special attention was given to the utilization of the head waters of the Rio Grande river at a point near the south end of the Culebra cut, where a small reservoir had been constructed by Mr. P. Bunau Varilla, at one time Chief Engineer of the Panama canal, the object being to supply water used in the excavation of the Culebra work.

The advantage of this location consisted in the fact that the United States government owned the entire water-shed, and that only two habitations had previously existed within its limits; that the water could be conducted along the right of way immediately adjacent to the railroad, requiring no negotiations for land, and admitting of the most economical construction, besides supplying the Panama railroad and adjacent territory along the canal with water for a distance of ten miles between the site of the reservoir and the city of Panama.

After comparing this source with others suggested, the Chief Engineer instructed Mr. Davis to investigate and report upon its utilization immediately upon his arrival. A careful investigation and analysis of the water and sources of supply resulted favorably, and on August 9, 1904, the Chief Engineer forwarded the Commission a report on the proposed water-supply system for the city of Panama, recommending its immediate construction at an estimated cost of $440,000. This estimate provided not only for the necessary reservoirs and main supply line, but also for a complete distributing system in the city of Panama. The location of the reservoir on the Rio Grande also assisted in solving the problem of taking care of the flood-waters of that river.

The system consisted of a main impounding reservoir, at an elevation of approximately 235 feet above the level of the sea, containing enough water to supply the city of Panama with 2,000,000 gallons daily—an average of sixty-six gallons per inhabitant, per day, on the basis of 30,000 population, which was at least fifty per cent. in excess of the present number of inhabitants—and continuing this supply for four consecutive months, without any addition to the supply in the original reservoir—should that improbable circumstance ever occur—the reservoir still holding sufficient water at the expiration of this period to preserve its potable quality.

This water was to be conducted to the immediate vicinity of Panama through a sixteen-inch main, and discharged into an auxiliary reservoir of 1,000,000 gallons capacity, situated at an elevation of approximately 140 feet above the sea level in the immediate vicinity of Panama, from which the water was conducted through a twenty-inch pipe to a connection with the distributing system in the city.

Numerous delays occurred in the construction of this water-supply system, due to the fact that the last shipment of sixteen-inch pipe for the water main did not arrive on the Isthmus until May, 1905—eight months after the requisition had been issued for it. The system was in final readiness for the delivery of water in the city of Panama at the close of June, 1905, although the auxiliary reservoir and the full local distribution would still require several months for completion. The relation between the principal water-main and the storage reservoir is such as to permit the water to be furnished to the city through a by-pass, directly from the collecting reservoir.

Simultaneously with the construction of this water-supply, plans and estimates were made for the construction of a sewerage system at an estimated cost of $275,000. The out-fall sewers had been constructed, and the work of installation of intercepting and lateral sewers was well under way at the close of June, 1905.

Even in the United States, it is rare indeed that a water-supply of this magnitude is conceived, designed and executed in so short a time; and considering the delays in securing the material, and especially the difficulty experienced in obtaining the proper quality and quantity of labor, the result of this particular installation was certainly gratifying. And the credit therefor is due to Mr. Carleton E. Davis and his efficient staff of assistants.

During the same period, Mr. Davis, through his staff, conducted surveys and furnished estimates and plans for the installation of a water supply for the city of Colon. The situation at that place being much more complicated than at Panama, it will require another year to construct the system. It will be necessary to change and raise the grade of the entire city before water and sewerage can be fully installed, and it will also be necessary to procure, either by purchase or condemnation, the land needed for the collecting reservoir and connecting mains.

Various minor reports and plans were also made by Mr. Davis and his staff for the installation of water-supply and sewerage at the various points along the line of the canal, the construction of which was generally well under way on June 30, 1905.

In addition to proper water-supply and sewerage for Panama, it is obvious that in order to maintain a proper state of cleanliness, the city should be provided with street pavements. Plans and estimates had been made for this purpose, but the question of the power of the Commission to make this expenditure in the city of Panama resulted in no action being taken to authorize the work until the appointment of the last new commission on April 1, 1905; and it was not until May that authority was received by the Chief Engineer to make requisition for the proper material.

The plan provides for three classes of pavement: In the central part of the city, a vitrified brick pavement laid on a concrete foundation; in other streets, vitrified brick pavement laid upon a macadam foundation; and on the outlying roads, macadam pavement, the estimated cost being $425,000 for the entire work.

The importance of providing suitable quarters for the increased force, which every steamer was bringing to the Isthmus, was thoroughly realized by the Chief Engineer upon his arrival, and on July 12, 1904, Mr. M. O. Johnson was appointed supervising architect, in charge of the construction, repair and maintenance of buildings. Mr. Johnson immediately proceeded to the Isthmus, and organizing his force, pushed the work with intelligence and vigor, although the disadvantages under which he labored were most discouraging. The mechanics immediately available and who could be secured from the surrounding countries were incompetent, shiftless and lazy; and owing to the governmental methods which surrounded the purchase of material at Washington, at no time during the year was there sufficient material on hand to meet the immediate requirements, although the material and supply department purchased everything offered in the local markets on the Isthmus.

One of the difficulties met with by the architects' department in caring for the existing buildings was that it was not easy to determine, until the buildings were in actual process of reconstruction, the full extent of the repairs needed, owing to the ravages of time. In some of the buildings which seemed substantial, when the floorings and sidings were removed, the beams, joists and hidden timbers would be revealed and found to be in poor condition, attributable to the effects of the climate and destruction by white ants.

It was generally the case that much more material was needed in repairing the buildings than could be determined by casual inspection before the work commenced: and as such a large number of buildings were supplied by the original French company, the Isthmian Canal Commission was naturally disinclined to make expenditures for the construction of new buildings, presuming that the repairing of existing structures would be sufficient to supply accommodations.

In February, 1905, however, authority was given for the construction of eight hotel buildings, providing general quarters for the staff; and by the first of May two hotels, three stories high and containing eighty rooms each, were erected, one near Corozal and the other at Culebra. These were completed, furnished and occupied prior to June 1, 1905.

Authority was also received for six other buildings of the same class, and plans had been made for their erection immediately upon arrival of the material. It is needless to enumerate the large number of buildings that were put in temporary condition for habitation.

This work was carried on in the following way: First, the temporary and immediate repairs of buildings to such an extent as would permit of their being inhabitable. Second, thorough repairs in order to place them in proper condition. Third, construction of additional new buildings.

On the 1st of June, 1905, 1,499 persons were employed in the architects' department, 211 of whom were Americans and skilled mechanics paid in gold, and the remainder mechanics and laborers, more or less skilled, drawn from the population of the Isthmus or the surrounding countries.

Mr. Johnson, who was efficiently conducting this department, worn out by the strain and responsibility which rested upon him, and further weakened by the debilitating effects of a tropical climate, was stricken with yellow fever, and in the latter part of April, 1905, fell a victim to the disease. However, his successor, Mr. Burt, assisted by Mr. Wright, took up the burden and work, and enthusiastically carried it forward.

Complaint as to lack of quarters was due to several causes, the first being the fact that the majority of the men imported from the United States evidently expected to find all of the conveniences and comforts of modern civilization available in eastern United States cities, and came unprepared and unwilling to put up with even temporary hardships and inconveniences, which are inevitable during the period of preparation and organization of construction work of this character.

Again, the employes in the departments of engineering and construction alone, on the 1st of June, 1905, had increased during the preceding year to approximately 7,639 men. This does not include the members of their families or those indirectly connected with the work, but only the names of those actually at work and on the payrolls; it does not include—figures for which are not at hand—the persons employed in the governmental, sanitary and other departments of the work, which would doubtless swell the total to over 10,000, ten per cent. of whom were actively engaged on the 1st of June providing quarters for the remainder.

There is no doubt that the present force could have been better provided for if the simple and established business methods could have been used that are everywhere employed in private enterprises for securing and furnishing men and material.

While working under the jurisdiction of the Walker Commission, prior to April, 1905, the chief of what was called the department of material and supplies was not under the control of the Chief Engineer, but reported to and received directions from the Chairman of the Commission; and it was not until the writer returned to the Isthmus in the latter part of May, 1905,—after the reorganization of the present commission—that the materials and supplies on the Isthmus were placed under his control, and a bureau of supplies was instituted.

The principal American commissary on the Isthmus was that under the control of the Panama railroad, which furnished such supplies as were required by the American employes, either to these employes direct or through the medium of the proprietors of such hotels and canteens as were established for their accommodation.

The regulations of the disbursing department, which prohibited deductions from the pay of employes for the benefit of proprietors of hotels and canteens, in liquidation of bills, was a serious difficulty, as it made the collection of board bills troublesome.

Under the circumstances it was difficult to procure qualified and competent persons to operate or establish boarding-houses and canteens. An alternate plan was the establishment of these facilities and their operation by the Commission.

Up to the date at which the writer left the Isthmus, no plan had been devised which would conform with the governmental regulations, and was practicable and workable under the conditions.

During March and April, 1905, the Panama railroad commissary was temporarily transferred to the control of the material and supply department of the Isthmian Canal Commission. Under the law that the gross receipts of all supplies sold would have to be covered into the treasury of the United States, and all payment for commissaries charged out against the Canal Commission, this department was retransferred to the Panama railroad, in order to avoid this complication, as the amount of all merchandise purchased for the commissary department would have fictitiously increased the cost of the canal to the amount of these purchases.

Under ordinary conditions, the providing of proper facilities for the feeding of employes would have been a very simple matter—if unhampered by governmental regulations and handled by the common-sense methods used by contractors conducting large construction operations.

The writer has intended in the foregoing pages to briefly indicate the situation on or prior to July 1, 1904, when he was placed in charge on the Isthmus; together with a brief description of that part of the work under his charge relating to water-supply and the sewerage necessary to supplement the work of the sanitary department. A subsequent article will treat of what was accomplished under the direction of the engineering and construction departments during the year ending June 30, 1905.

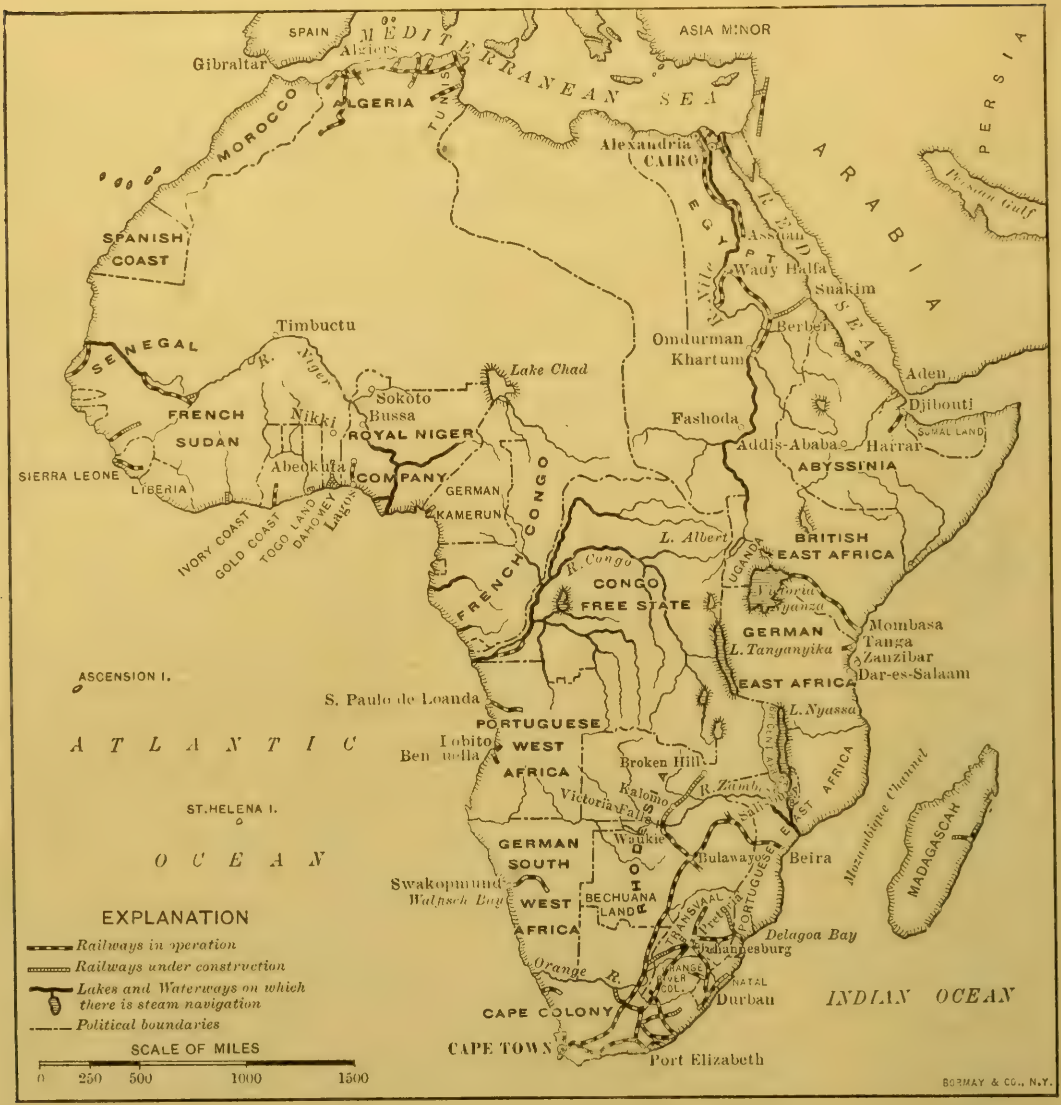
RECENT PROGRESS ON THE CAPE-TO-CAIRO RAILWAY.

By J. Hartley Knight.

The recent opening of the bridge over the Zambesi River at Victoria Falls, and the South African meeting of the British Association this summer, when the members travelled by rail to this great cataract in the heart of Africa, have directed attention to the progress which the Cape-to-Cairo Railway is making, and in the present article Mr. Knight gives a most interesting account of the status of this tremendous undertaking, and also describes some of the branch roads from the coast, which will act as the feeders of the main trunk line, and which, in turn, will be fed by it.—The Editors.

FIVE years ago I was privileged in these pages to relate in some detail the story of the inception of the Cape-to-Cairo Railway scheme and to give an account of the work then actually accomplished. It may be remembered that in the endeavour to trace the origin of the scheme I showed how, in 1879, Sir (then Mr.) James Sivewright, at that time telegraph superintendent to the Cape Government, had conceived the idea of connecting the south of Africa with the north by means of a telegraph wire; and I further showed that the Cape-to-Cairo project was foreshadowed in 1888 by Sir Charles Metcalfe, Bart., who was inspired with the idea of calling the prospective Bechuanaland Railway the "Central African Trunk Line." In a word, I questioned the popular opinion that the scheme had originated in the fertile brain of the late Mr. Cecil Rhodes, at that time happily still with us,—although I gave, or tried to give, full credit to that distinguished statesman for having, as it were, crystallised the idea, and materially assisted to popularise it by the wonderful enthusiasm he displayed and the practical support he lent to its realisation. I did not then know, although I have since been informed of the fact, that the phrase "Cape to Cairo" was first actually employed by Sir Charles Metcalfe, who used it in an article he wrote for the *Fortnightly Review* somewhere in the year 1889.

The purpose of this article is, however, not to discuss a matter which is after all not of very great consequence, but rather to show how the scheme has progressed during the past five years. When death removed from South African political life the dominating personality of Mr. Rhodes, there were not wanting those who predicted the speedy abandonment of the "fantastical Cape-to-Cairo Railway scheme." There was perhaps some justification for this belief because,



AFRICAN RAILWAYS AND WATERWAYS.

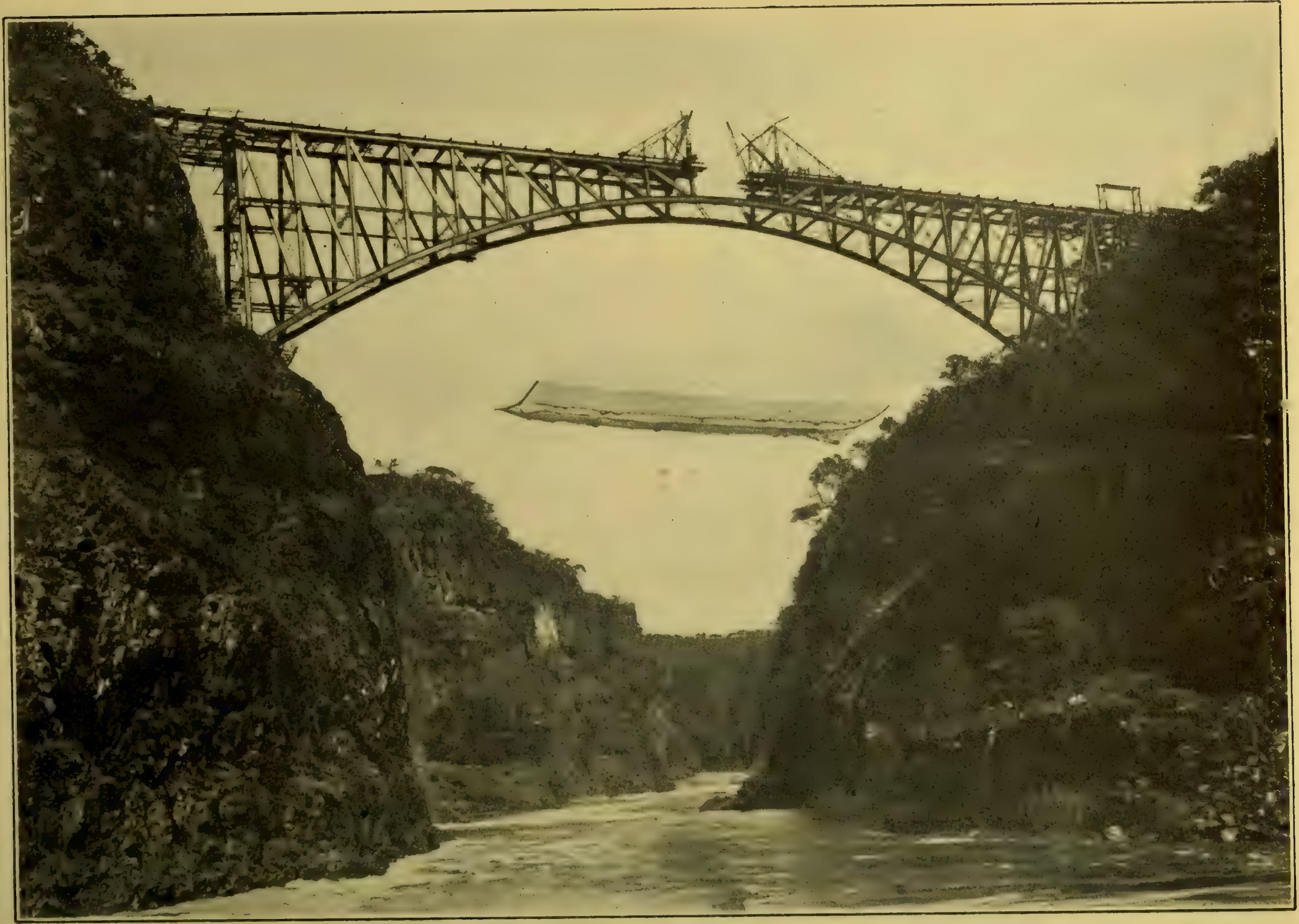
as I showed in my previous article, Mr. Rhodes's name was so indissolubly bound up with the scheme that many thought that the demise of the one assuredly meant the death-blow of the other. But as events have proved, the project has not suffered in any way—certainly not so far as the southern portion of the line is concerned. The position created by Mr. Rhodes during his lifetime was such that his work was bound to go on after his death. This was very clearly explained at the time of Mr. Rhodes's death in a note issued to the shareholders of the British South Africa Company by the late Mr. J. F. Jones, the joint manager and secretary, who, in the course of a dignified tribute to his chief's memory, observed:—"It is not the least result of the work of Mr. Rhodes that the destinies of Rhodesia and

VICTORIA FALLS.

The falls are over 400 feet high and about a mile wide from bank to bank, with several islands intervening.

of the company have ceased to depend upon the life of any individual. The organisation which was due to his genius has been established upon a permanent basis. The development of the natural resources of Rhodesia will continue and the finances of the company are to-day equal to any strain that is likely to be cast upon them." Possibly had Mr. Rhodes lived the project as a whole would to-day be more advanced than it is—particularly in the regions north of Rhodesia—but so far as the sub-continent is concerned it is surely matter for congratulation to all concerned that so much good solid work has actually been accomplished.

Quite recently I had the opportunity of discussing this very subject with Sir Charles Metcalfe, who, *en parenthèse*, has been the leading spirit of the railway all through. I told him that in some quarters the impression still remained that the death of Mr. Rhodes had adversely affected, and was still affecting, the great railway scheme. Now, as Sir Charles Metcalfe is so closely associated with the project it was perhaps hardly fair to expect him to say very much either way, but he agreed with me that, so far as he was aware, the railway scheme had not suffered to any appreciable extent, if indeed at all, by the

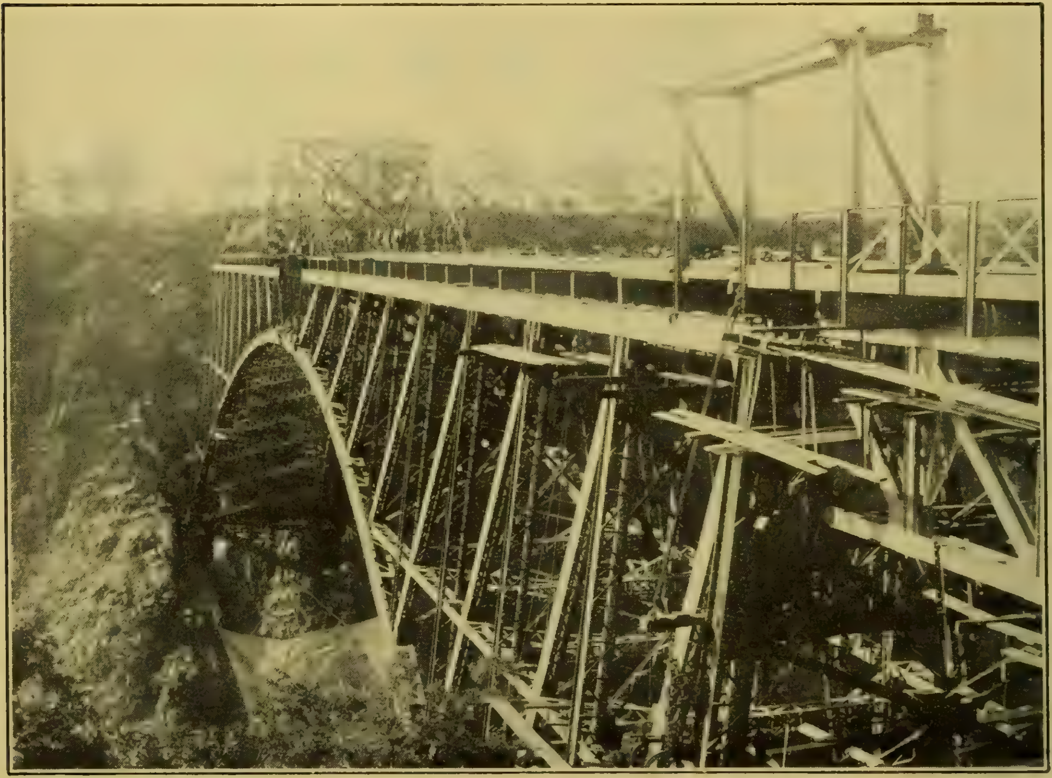


ZAMBESI RIVER BRIDGE, SPANNING THE GORGE BELOW VICTORIA FALLS.

demise of his lamented friend; and he added that if it were otherwise the line from the south would scarcely be where it is to-day, namely, a good many miles beyond Kalomo and well on the way to Rhodesia Broken Hill, the next great stage to the terminus on the southern end of Lake Tanganyika. "It must be admitted," Sir Charles proceeded, "that Providence has been very kind to us in regard to the stretch of country north of Bulawayo, in that we have coalfields at Wankie to help us along and are now making straight for Broken Hill which, as you are aware, is a rich copper region." He further stated that some people seemed to think that sentiment was at the bottom of Mr. Rhodes's plans respecting the railway, whereas the latter had always regarded the matter from a hard-and-fast business standpoint. "The fact that we are where we are to-day with the railway shows, I think," Sir Charles Metcalfe added, "that we are doing what Mr. Rhodes would have done." What my interviewee said about the supposed underlying sentiment is, in a measure, borne out by Mr. Rhodes himself in a letter he addressed to a young Cambridge graduate, to wit, Mr. Ewart S. Grogan, who has the distinction of being the only white man who has traversed Africa from south to north. Such a feat, said Mr. Rhodes in effect, "makes me the more certain that we shall complete the telegraph and railway. . . . As to the commercial aspect, the object is to cut Africa through the centre and the railway will pick up trade all along the route. The junctions to the east and west coasts, which will occur in the future, will be outlets for the traffic obtained along the route of the line as it passes through Africa. At any rate to Bulawayo, where I am now, it has been a payable undertaking, and I still think it will continue to be so as we advance into the far interior."

The extension of the line to the Wankie coal district, northwest of Bulawayo, was in contemplation at the time my former article appeared in The Engineering Magazine. Owing to the Boer war the work was somewhat retarded. It was originally intended that the line from Bulawayo via Gwelo (and thence to Salisbury and the Portuguese port of Beira) should form the first section of the main line northwards from Bulawayo towards Tanganyika. It was also intended that the line should traverse the Mafungabusi district and cross the Zambesi in the vicinity of the Kariba Gorge. It was, however, found on further examination of the proposed route that the country north of the Zambesi at that point is very difficult for railway construction. "Further,"—I am now quoting from the British South Africa Company's official report—"though the indications of coal in the Mafungabusi district are numerous and promising, sufficient work had not been done to enable the economic value of those fields to be compared with that of the Wankie coalfields." Thus it came to pass that the Wankie route was selected, the wisdom of which step has since been made manifest. The line—203 miles in length—was begun in May, 1901, and finished in September, 1903.

Then was commenced what by many is regarded as the most interesting portion of the southern half of the Cape-to-Cairo Railway, namely, the section which includes the world-famous Victoria Falls. The link in question—from Wankie coalfields to the Falls, some 75 miles—was begun on the 21st of September, 1903, and finished on the 25th of April, 1904, and the whole line from Bulawayo to the famous cataract was opened for traffic on the 20th of June. A few weeks later the first through train from Cape Town started amid enthusiastic demonstrations. It is interesting to record that the first locomotive to cross the River Zambesi at the Victoria Falls was taken over by means of an enormous cableway spanning the gorge, as the bridge was not then built. It was necessary to entirely dismantle the engine and draw the tubes from the boiler in order to reduce the



ZAMBESI RIVER BRIDGE AT VICTORIA FALLS.

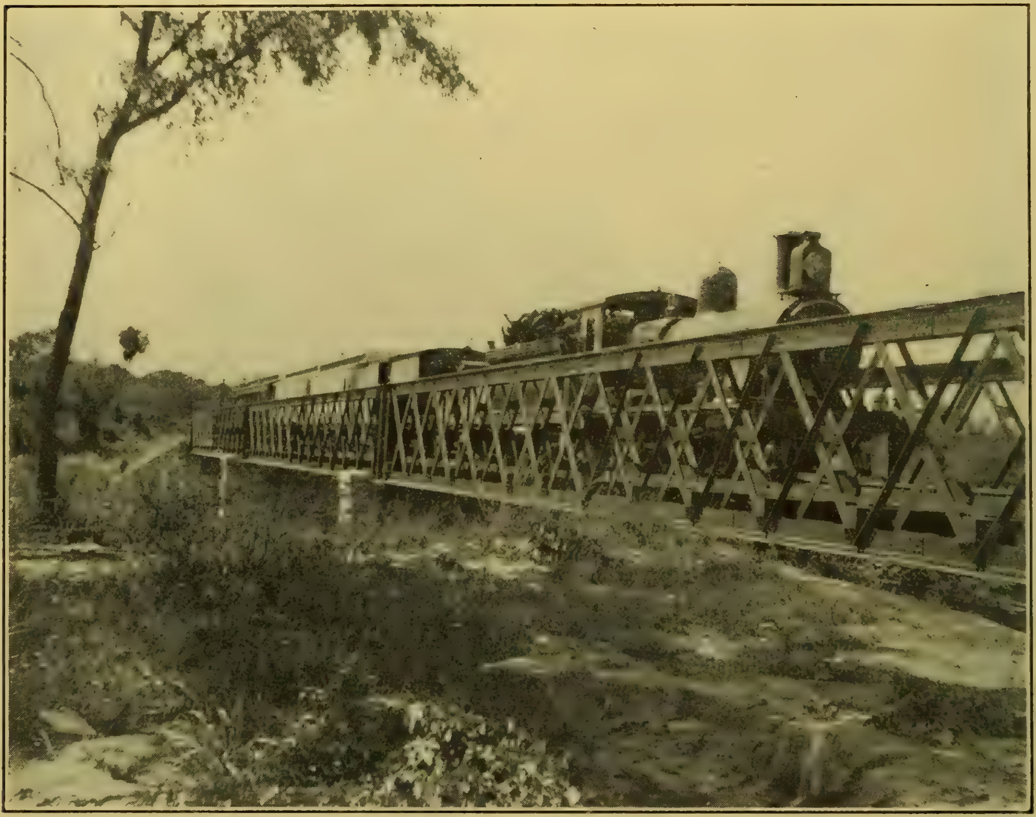
Day of linking in, April 1st, 1905. The net underneath is for the purpose of catching workmen and tools which may fall from the structure.

weight sufficiently to enable the cableway to deal with it. The heaviest piece that was taken over weighed about nine tons.

Whilst the bridge was building the work of laying the metals on the track north to Kalomo was proceeded with, all the material for that section being conveyed across the gorge by the so-called "Blondin" transporter, which did splendid work in this particular. The cable to which the transporter was attached was of steel and was fixed to a steel tower on either side. The transporter, driven by electricity, and with a carrying capacity of five tons, took across the sections of half the bridge, as well as the rolling stock, and all the material for 50 miles of roadway. The Zambesi bridge, or the Victoria Falls bridge, as it is variously called, is a record bridge in many respects. It is the highest—420 feet—in the world, and it was built in the shortest time recorded for such a work, viz., nineteen weeks. Sir Charles Metcalfe also claimed that no other bridge of its size and capacity had ever been built so cheaply. At the time of writing the bridge is still incomplete, some 50,000 rivets having yet to be hammered in before the finishing touches can be made. The bridge was designed by Sir Charles Metcalfe, consulting engineer in Africa of the Rhodesia Rail-

CATUMBELLA BRIDGE, LOBITO BAY RAILWAY, PORTUGUESE WEST AFRICA, 350 FEET LONG.

ways, Limited, and Mr. G. A. Hobson, M. Inst. C. E., of the firm of Sir Douglas Fox and Partners, the same company's consulting engineers in London. The work of construction was under the immediate charge of Mr. G. C. Imbault, who had with him a staff of English bridge builders, which never exceeded 25 men, and about 100 native labourers. This gentleman practically superintended the construction of the bridge at Darlington, where it was made by the Cleveland Bridge and Engineering Company, and also its erection across the Zambesi. The total length of the bridge is 650 feet, of which the central span accounts for 500 feet between the pin centers on the two banks, the balance being made up of the two short spans. The great center span rises in a graceful parabolic arch to the center, the spring of which starts from the bases of the main booms. The vertical rise to the crown is 90 feet. The main span is made of 20 bays each 25 feet long; and lateral stability was secured by a wide spread at the feet of the bridge. At the rail level the distance between girder centers is 27 feet, 6 inches, whereas at the bases the width between pin centers is 50 feet. The roadway projects beyond the side girders so as to allow a clear 30 feet between parapets. The bridge is of steel, and as it is



GWAAR BRIDGE, 90 MILES FROM BULAWAYO ON THE WAY TO VICTORIA FALLS.

coated with grey paint it is rendered as invisible as possible against the cloud of spray—"the smoke that sounds," as the natives call it—that rises from the Falls and the undue obtrusion on the landscape which so many feared has thus been obviated.

According to Mr. G. A. Hobson, the most difficult portion of the work was at the beginning. It was anticipated that the footings of the bridge could be formed of the face of the solid rock, but a closer inspection revealed the fact that the surface was covered to a considerable depth with loose debris, which had to be cleared away. The result of this was that it was found necessary to place the bridge at a level 21 feet below that originally selected and to set the hinged base pins in foundations of armoured concrete. "Once we began to build the arch outwards from either bank," said Mr. Hobson, "everything was plain sailing, and the work went on with the smoothness and regularity of clockwork." So carefully had the whole thing been thought out that the two ends of the bridge, which was built from both sides on the gorge simultaneously, met so exactly that there was not a difference between them of even an eighth of an inch. The actual erection of the bridge commenced on October, 1904, and the girders were joined on April 1, 1905.

TRAIN AT THE GWAAR BRIDGE, VICTORIA FALLS LINE.

During the construction of the bridge across the Zambesi the laying of the railway in a north-easterly direction to Kalomo went on uninterruptedly at the rate of a mile and a half per diem, and only a few weeks back the welcome intelligence reached London that the objective, a little under 100 miles, had been reached. From Kalomo to Broken Hill is 260 miles, with the River Kafue almost half way between. Here a bridge, some 1,700 feet long, will have to be constructed. It is anticipated that the line will reach the zinc and copper districts in June next year. Engineering difficulties en route there are practically none. The country being free from undulations it is proposed by the Rhodesia Copper Company to construct a light line to connect the various mining properties of the company, so that in the fulness of time this district is likely to be a network of railway lines and a scene of great commercial activity. I understood from Sir Charles Metcalfe that for the present at all events no definite arrangements have been made to carry the line beyond Broken Hill, and he politely begged to be excused when I pressed him for an approximate date for the arrival of the iron horse at Abercorn, on the southern end of Lake Tanganyika. "My own opinion," remarked the baronet, "is that in the future there will probably be two lines running from Broken Hill—one going up through the Congo Free State, to Lake Chad and right through French territory, coming out perhaps at Algiers or some other place on the north coast; the other coming up through German East Africa and ultimately joining up with Khartoum and Cairo."

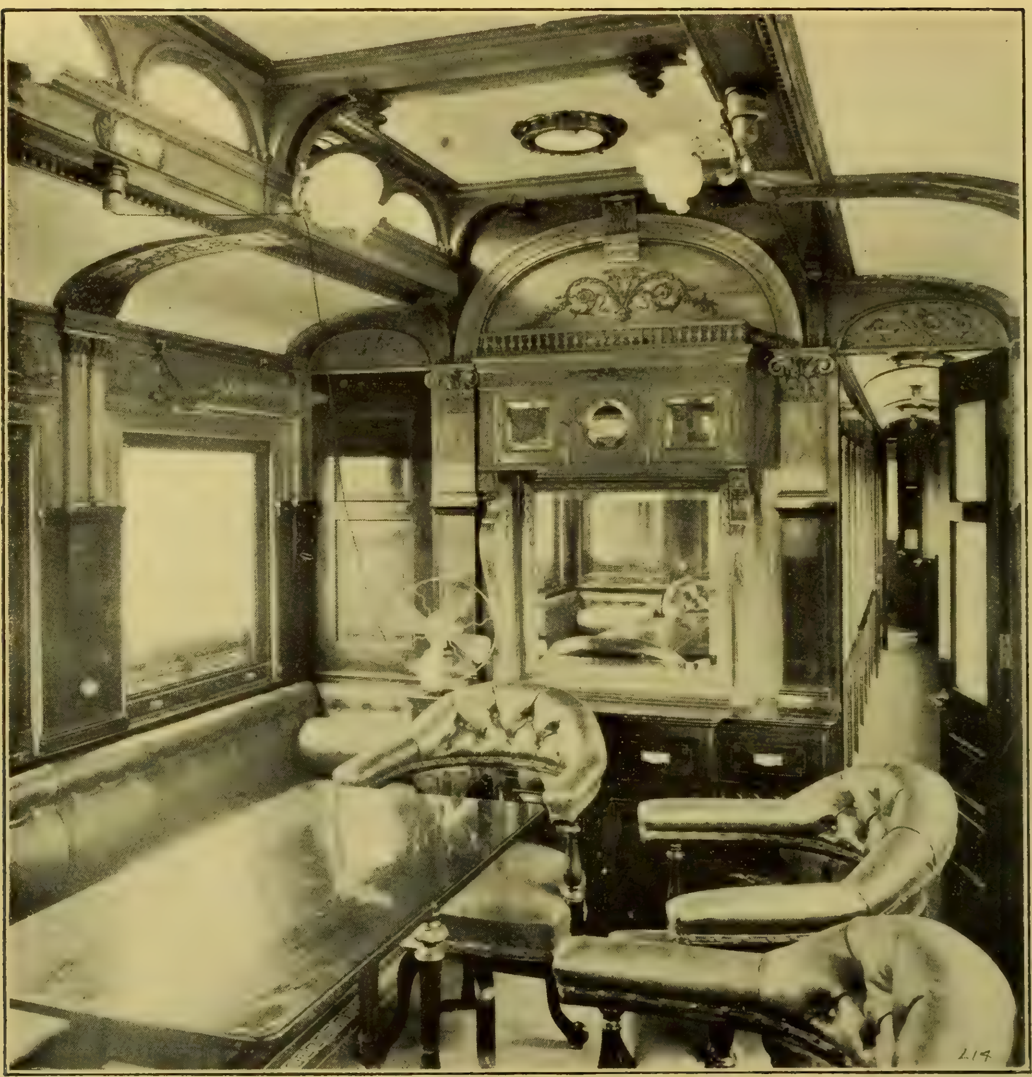
DOUBLE-BOGIE KITSON MEYER LOCOMOTIVE, RHODESIA RAILWAYS.

Designed for sharp curves and heavy traffic.

For the time being, then, the railhead of the Cape-to-Cairo Railway will be at Rhodesia Broken Hill, which is about 1,984 miles from Cape Town. When the next section will be taken in hand will depend very much on circumstances, chiefly, it would seem, of a financial character. And whether too, the route favoured by Mr. Rhodes will ultimately be followed and the waters of Tanganyika utilised in preference to constructing a line on its eastern bank also remains to be determined. Sir Charles Metcalfe favours the railway line in preference to the waterway, but I think it is exceedingly doubtful whether that line will ever be constructed, railway construction in that part of Africa, which is German territory, being eyed somewhat askance by the powers that be in Berlin.

Turning once more to my article in THE ENGINEERING MAGAZINE of five years ago I find that I said:—"In twenty years' time, it is safe to prophesy, railway development in Africa will have made enormous strides, and many important branch lines to connect with the Cape-to-Cairo trunk will have been constructed or be near completion." Already very considerable progress has been made in this direction, and among other lines which have been completed since the statement was made is that between Bulawayo and Beira—viâ Salisbury—in Portuguese East Africa, a very important "feeder," indeed, to the Cape-Cairo trunk; and the line which begins at Mombasa, in British East Africa, and ends at Port Florence on Lake Victoria Nyanza, a matter of 584 miles. It is interesting to recall the fact that the first locomotive reached Port Florence on December 19, 1901. The first rail at the sea coast was laid on August 8, 1896, and the whole length of line was thus completed in four years and four and a half months. More important still from the point of view of the Cape-to-Cairo line is the railway which is now in process of construction from Lobito Bay, in Portuguese West Africa, to Katanga, in Belgian Central Africa, some 900 miles distant. It is a foregone conclusion that if ever this line gets to Katanga it will not be long before it joins the Cape-Cairo trunk, at a point yet to be determined but probably at Rhodesia Broken Hill, and thus directly connect with Beira in the east and Cape Town in the south. The concession to construct the line was granted to Mr. Robert Williams a couple of years ago, on the understanding that the

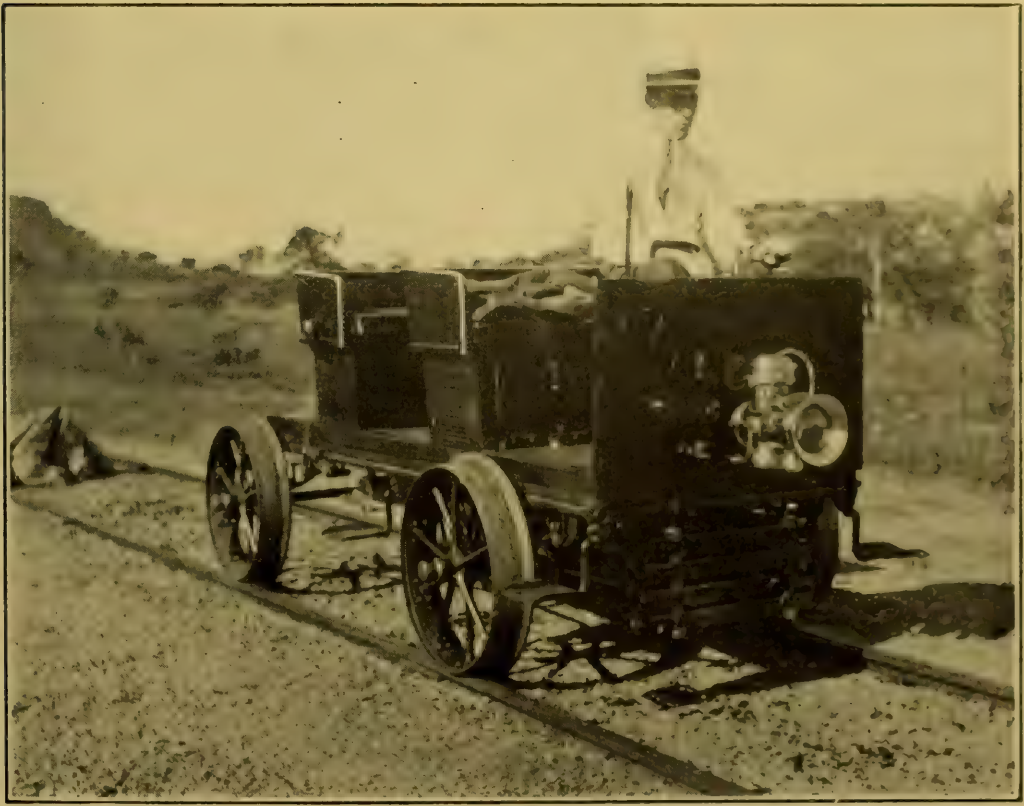
PRIVATE SALOON CAR, RHODESIA RAILWAYS.



INTERIOR OF TRAIN-DE-LUXE, RHODESIA RAILWAYS.

Portuguese Government obtained 10 per cent. of the issued shares and 5 per cent. of the net profits that may accrue, they themselves not guaranteeing a halfpenny. In return for this Mr. Williams is granted the exclusive mining rights over all minerals, supposed to be very abundant in this locality, found for a distance of 120 kilometers north and south of the rail route, which by-the-bye, is to be followed up by the construction of a telegraph line. The contract for the construction of the railway was secured by Messrs. Griffiths and Co., and the first section of the line, as far as Benguella, is now practically completed, and will be immediately followed up by the construction of another link to Monte Sahoa. I understand that the only engineering difficulties which present themselves on this route are to be found in the first portion thereof—up to Monte Sahoa. Black labour from the negro republic of Liberia is being employed on this line and is said to be both cheap and good. Rubber and wax in large quantities are met with en route, whilst at Katanga there is an abundance of copper. Unquestionably this line, when completed, will have a very important bearing on the Cape-Cairo route; and as Lobito Bay is four or five days nearer England than Cape Town it is already seriously suggested that it may "some day" prove to be a very formidable rival indeed to the capital of the Cape Colony.

It would require more space than I have at my command to indicate, with anything like sufficiency of detail, the progress which has been made in the last five years with the numerous railway projects in various parts of Africa, some of which have a bearing on the great trunk line,—notably in the huge region under French sway in the western and northwestern portion of the continent, where a truly wonderful transformation is being effected, thanks chiefly to the advent of the iron horse. In the Congo Free State the railway is also slowly but surely advancing; and in Abyssinia it would appear that the jealousies of the various European Powers are not, after all, to be permitted to interfere with the progress of the much-debated railway. In



SIX-HORSE-POWER DE DION GASOLINE MOTOR CAR ON THE RHODESIA RAILWAYS.

Pauling & Co.

TRAIN ON SUDAN RAILWAY, WITH BALDWIN LOCOMOTIVE.

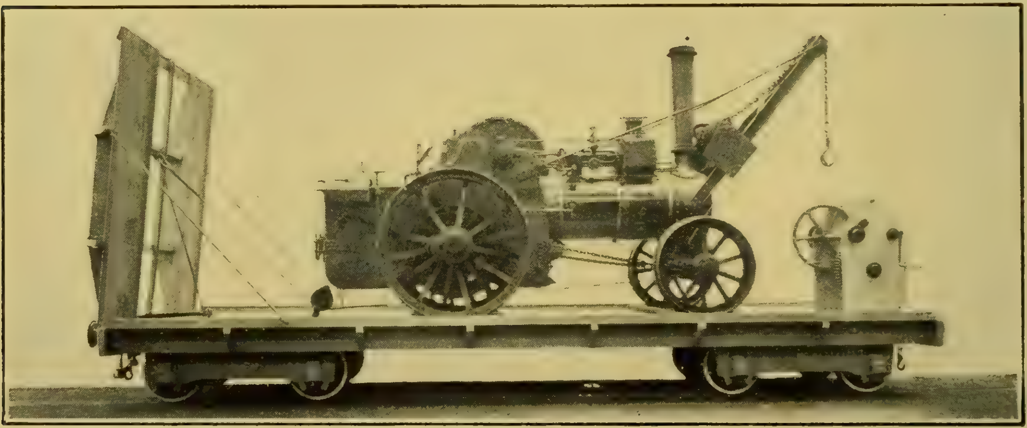
April last the Emperor Menelik told the representatives of the Powers, assembled at Addis Abeba, very plainly that their barren discussions were delaying the construction of the line and in view of the situation thus created he declared that if he received from the Powers no proposal placing the various international interests in agreement, he would himself undertake the construction of the railway without soliciting or accepting any co-operation.

Small progress also remains to be chronicled in regard to the railway projects of German East Africa, of which so much was expected in connection with the Cape-to-Cairo scheme. It was originally proposed that the line commencing at Dar-es-Salaam should join the Cape-Cairo trunk at Ujiji, on the eastern side of Lake Tanganyika, taking in Mrogoro and Tabora en route. But things would appear to be in a bad way, financially speaking, in the German colony, and certainly but small sympathy with its railway aspirations has been shown in the Fatherland. Speaking in the Reichstag three years ago Dr. Stübel, Director of the Colonial Office, voiced the national feeling on the subject. He said it was proposed "for the present" to construct only the portion of the central railway connecting Dar-es-Salaam with Mrogoro. This section, he added, was designed to open up the highlands of German East Africa and was in no sense related to the Cape-to-Cairo scheme. Dr. Stübel further declared that the Cape-to-Cairo

TRAIN DE LUXE, OUTSIDE BULAWAYO STATION, RHODESIA.

Railway was a "phantom which would not bear comparison with other transcontinental railways such as those existing in America and Asia." The position to date seems to be that the line from Tanga on the coast to Lake Victoria Nyanza leads only 150 or 160 kilometers inland, whilst the projected line from Dar-es-Salaam to Ujiji is no more "forrader" than it was three or four years ago.

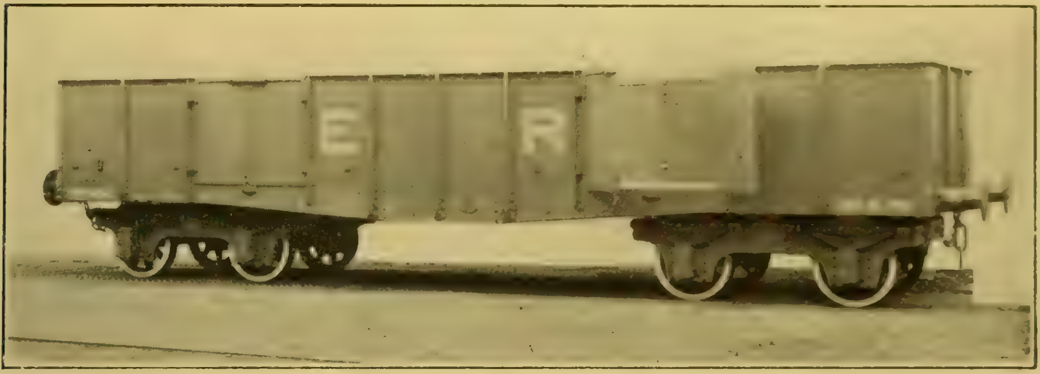
Coming to the northern section of the Cape-to-Cairo scheme, the extension southwards from Khartoum, the position remains much as it was four or five years ago. As a scheme pure and simple Lord Cromer apparently does not think very much of it, and it may be taken for granted that he will do nothing to directly further its interests. His opinion of the scheme was expressed very clearly in his official report on Egypt published in April, 1904, in which he stated that while he was not prepared to say that, from a purely engineering point of view, the execution of this plan—i. e.; the establishment of a continuous railway communication from Cairo to Cape Town—"would be absolutely impossible," he was quite confident that, in view of the very great physical difficulties which would have to be encountered, the cost of constructing any such railway would be altogether out of proportion to its utility. Proceeding, Lord Cromer said:—"I am, however, given to understand that this project—if it was ever seriously entertained—has been abandoned, and that the idea of establishing communication by rail and river between Cairo and Cape Town has been substituted in its place. This is altogether a different matter. A very difficult, if not the most difficult, part of the original project is thus abandoned, for it would be no longer necessary to construct a railway across vast marshes lying, roughly between the 5th and 10th parallels of north latitude. I cannot," said his lordship in conclusion, "speak with any authority as regards the difficulties which, in the execution of the revised project, might have to be encountered south of Gondokoro. All I need say is that the Egyptian and Sudanese part of the work is already accomplished. A regular tourist service by rail and river now runs from Cairo to Gondokoro." Obviously, when Lord Cromer penned these words he was more concerned with railway construction nearer home—in especial, with the extremely important section between Suakim and Berber, on the completion of which he has set his heart. All unconsciously, maybe, Lord Cromer has done not a little in helping materialise the late Mr. Rhodes's pet project. Lord Cromer, as was very truly pointed out the other day by a writer in the *Morning Post,* "has always looked towards the south," whilst "Mr. Rhodes always looked towards the north; the works of either, growing in the direction of either's gaze, are now coming together like the ends of a vast cantilever bridge." A year or so ago Sir Charles Metcalfe (who apparently reckoned without the brilliant administrator of Egyptian affairs) pointed out that if the Egyptian Government decided to build the proposed dam at Rosaire it was quite on the cards that the railway would be extended from Khartoum to Rosaire —which, in turn, would eventually be linked up with the Uganda railway. This accomplished, all that would be required to complete the great link from the north to the south would be a line of 600 miles



25-TON BOGIE CAR FOR TRANSPORTING STEAM PLOUGHING ENGINES.
Designed and built by the Leeds Force Co., Ltd., for the Egyptian Railway.

connecting the Uganda Railway with the Rhodesian terminus on the southern shore of Lake Tanganyika. And with all deference to Lord Cromer's inuendo that the Cape-Cairo railway would not be a commercial success it would be strange indeed, as the aforesaid writer is at pains to point out, "if a well-built railway, running through a fertile, elevated country in a continent almost two thousand miles broad and able to send out branch lines or feelers for traffic on either side, should not in the end, show a profit on its working."

So far—at its southern end at least—the Cape-Cairo railway has not been unproductive. I am of course referring to the Rhodesian section only. The official returns of the Rhodesia Railways, Limited, for the year 1904-5 are not yet available, although they will doubtless be forthcoming soon. But the figures for the previous year are to hand, and these show that between April, 1903, and March, 1904, inclusive, the revenue was £573,286 16s. 8d., the expenditure £434,542 16s. 1d., the net revenue thus being £138,744 0s. 7d., and the percentage of expenditure to receipts 75.80. For the year ending 31st March, 1903, the revenue was £526,560, the expenditure £322,774, the net revenue £203,786 and the percentage of expenditure to receipts 61.30. When the depression under which South Africa is still labouring is removed and the waters of the Victoria Falls are "harnessed" for electrical production it is only reasonable to assume that the Rhodesian railways will be worked at considerably less cost and that the net revenue will be proportionately greater. At the present rate of progress the next five years should see some wonderful developments in the African railway world, and speaking personally I shall be very greatly surprised indeed if by that time the Cape-to-Cairo Railway is not within a stone's throw, as the saying is, of Lake Tanganyika.



30-TON BOGIE COAL CAR, EGYPTIAN STATE RAILWAY.
Constructed by the Leeds Force Co., Ltd.

THE DOCKYARDS AND SHIP-BUILDING PLANTS OF JAPAN.

By Chas. Albertson.

II. PRIVATE ESTABLISHMENTS.

One of the most important questions of the present day is to what extent Japan will be able not only to supply her own needs, but also to enter into active competition with Europe and America in the markets of Asia, in the near future. Mr. Albertson's article is therefore of peculiar interest as throwing much light on an industry which is of leading importance, both from a manufacturing and a commercial standpoint.—THE EDITORS.

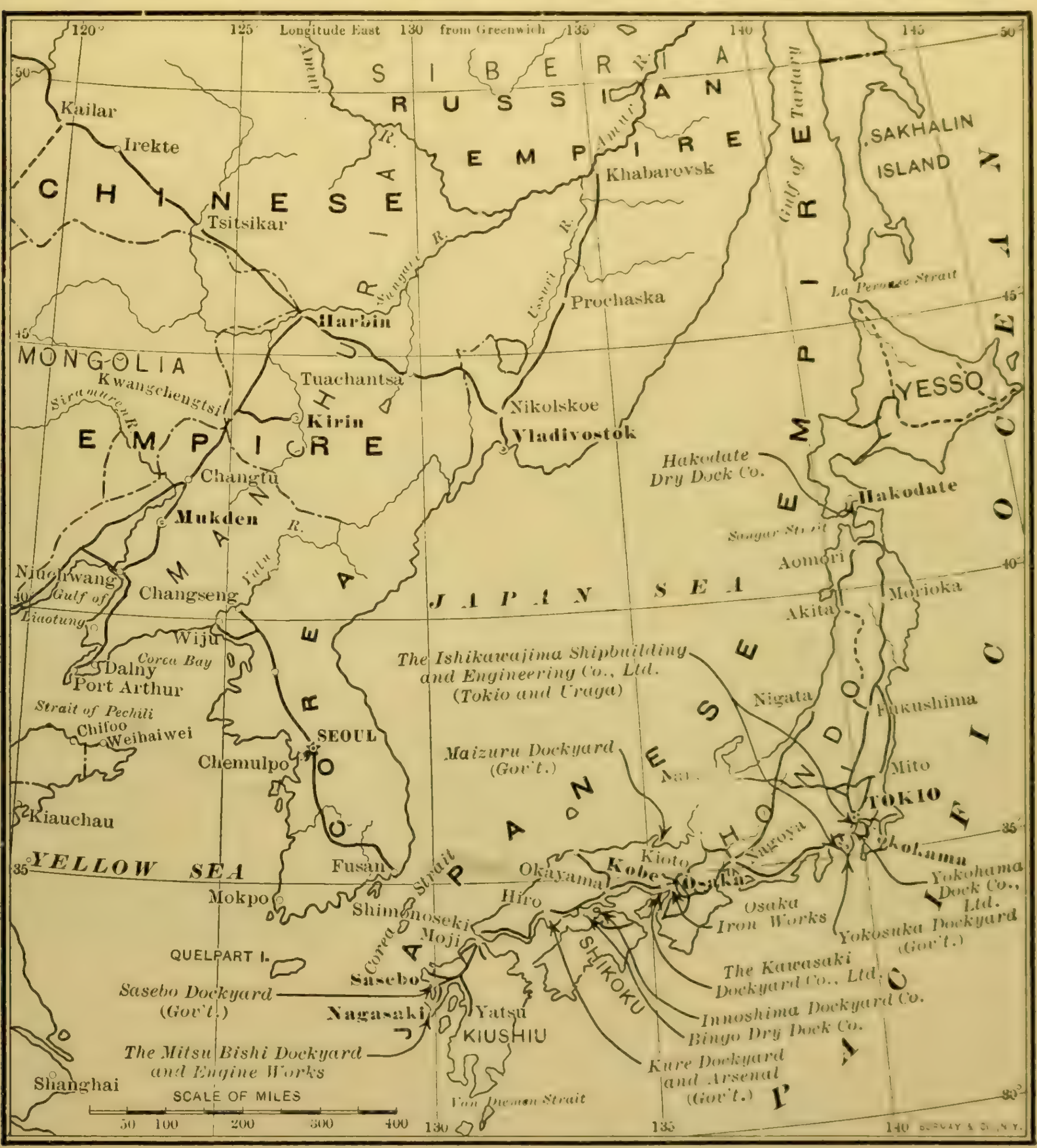
IN a previous paper, after a broad discussion of industrial conditions in Japan, the general ship-building statistics were given, and the Government dockyards described. The present article takes up the private establishments for ship-building and repair work, and treats them in fuller detail.

Mitsu Bishi Dockyard and Engine Works.—These works are for the most part on the northwestern shore of the harbor of Nagasaki and opposite the city of Nagasaki. The pretty harbor averages about one-half mile wide, is three or more miles long and is located at the southwestern extremity of Japan, which makes it a very convenient rendezvous and refitting station for all naval fleets in Far Eastern waters. The war vessels of half-a-dozen different nations are often at anchor here at one time. Most of the Pacific, European and other liners call at Nagasaki for coal, if for no other purpose.

In 1856 the Shogun built a small engine works at Akunoura, importing Dutch machinery and Dutch engineers to take charge of the plant. Akunoura is on the eastern end of the company's present premises and is to-day occupied by one of the best, if not the best, engine and boiler-building plants in all the East. The yards have a water front of one and one-half miles and the area occupied is about eighty acres. The original works, after serving the Shogun Government in doing repair work on very small vessels for about ten years, came into the possession of the government of His Imperial Japanese Majesty, the present Mikado, at which time they were greatly improved.

What is now the No. 1 dry-dock, since lengthened, was then built at Tategami, located at the western end of the premises, and a patent slip at Kosuge on the south side of the harbor, owned by a British merchant, was purchased. In 1884 the entire plant was sold to Barons Y. Iwasaki and H. Iwasaki, who are the proprietors of the Mitsu Bishi Company, which, besides owning this great concern, controls other large industrial enterprises in Japan.

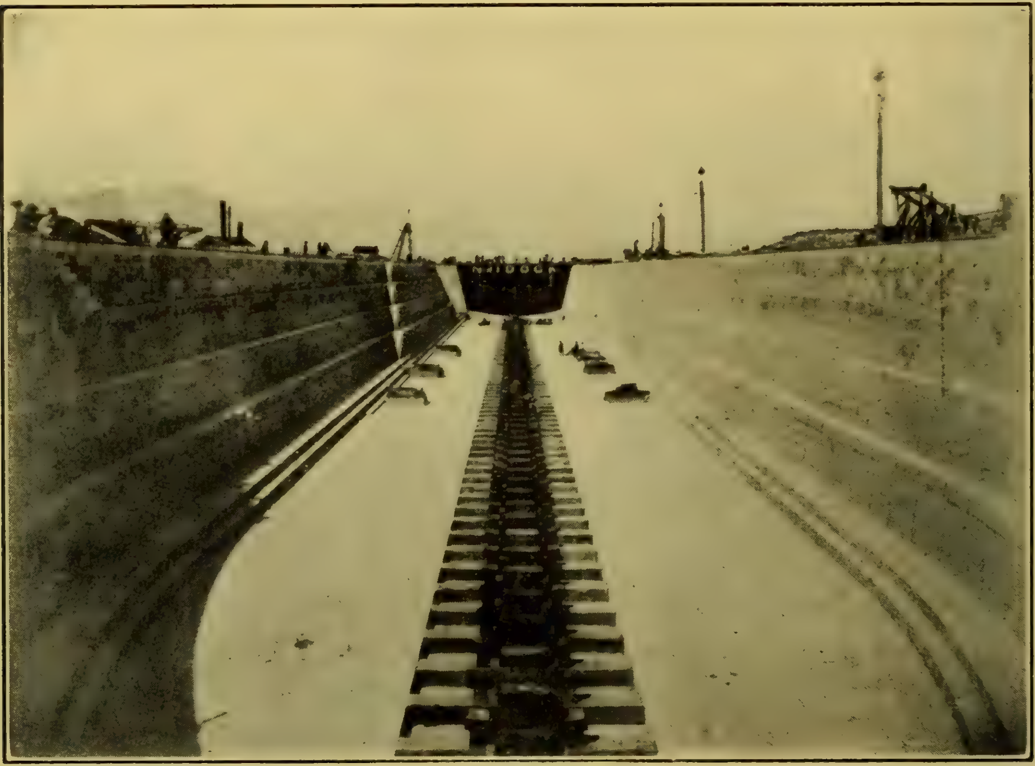
These ship-building and engine works are then the oldest and most extensive in Japan. They have in use three dry-docks and one



JAPAN AND NEIGHBORING COUNTRIES, SHOWING PARTICULARLY THE LOCATION OF THE JAPANESE SHIPYARDS.

patent marine slip. The big dock can accommodate the largest ironclads and merchant ships which now float the Pacific, and since these are as large as any in the world, the immense size of the new drydock is readily apparent. The company is prepared to undertake any kind of marine work whatsoever, including the heaviest, since it has lately installed the very largest and latest types of necessary machinery, has exceptional docking facilities, and is greatly extending the area covered by permanent buildings.

The tonnage of vessels launched from 1885 to 1894, inclusive, would scarcely average 250 tons per year, although the company did a very large docking and repair business. Since then, however, the ship-building end of the business has rapidly increased and the works can now easily turn out 20,000 tons yearly. In 1895 about 2,500 tons were launched; in 1898 about 8,000 tons; in 1899 about 4,000 tons; in 1900 about 11,300 tons; in 1901 about 7,200 tons; in 1902 about 15,875 tons; and in 1903 about 13,100 tons. From 1885 to 1897, inclusive, the indicated horse power of engines built in the shops would not average more than 600 yearly. Since then, up to 1903, the yearly horse powers follow: In 1898, 4,225 horse power; 1899, 3,200 horse power; 1900, 13,500 horse power; 1901, 6,240 horse power; 1902, 13,340 horse power; 1903, 11,463 horse power.



GRAVING DOCK OF KAWASAKI DOCKYARD CO., LTD.

Length, 426 ft.; width at top, 64 ft.; depth, 24 ft.

There are on the office and yard staff about fifty men, including six foreigners. The total number of workmen employed from 1884 to 1893 started at 766 and ran up to 1,200. At the end of 1897 the number had increased to 3,800, and then remained stationary until the end of 1900. At the end of 1903 there were 5,658 men on the pay roll. These tables show very decidedly the increase in capacity and business since about the time of the war with China.

In 1898 the first 6,000-ton steamer was launched, since which time this yard has built six others just as large, six of about 2,500 tons, six of about 1,600 tons, besides a half dozen smaller ones. They have built for the Imperial Japanese Navy one 120-ton torpedo boat and two each of 82 tons, the Government furnishing the materials. They have also constructed two dredges of 500 gross tons each for the Wakamatsu Harbor Works, and a large number of small craft of various types from 100 to 300 tons. The company is proud of the twin-screw steamship "Aki Maru," of 6,443 gross tons and 5,448 indicated horse power, now belonging to the Nippon Yusen Kaisha and ordinarily in service on the American line running to Seattle; also of the little steam yacht "Hatsukaze" of 80 tons gross and 200 indicated horse power, built for the use of the Crown Prince and launched in 1902. Japanese art has figured largely in the trimmings and furnishings of both these ships and the result is unique as well as highly satisfactory.

The dimensions of the three dry-docks, all of which are faced with granite and built in solid rock are as follows:

	Length on keel blocks.	Top entrance width.	Bottom entrance width.	Depth of water on blocks at spring tide.
No. 1 Dock.	510 feet	89 feet	77 feet	26 feet 6 inches
No. 2 Dock.	350 feet	66 feet	53 feet	24 feet
No. 3 Dock.	714 feet	96 feet 7 inches	88 feet 7 inches	34 feet 6 inches

The patent marine slip owned by the company has a length of rail of 750 feet, width between rails of 30 feet, and it is capable of taking vessels weighing up to 1,000 tons.

The company is prepared to undertake extensive salvage operations, having built especially for this purpose the steamer "Oura Maru" which is 186 feet long, 29 feet beam, 16 feet depth, and 712 tons gross. She is fitted with four centrifugal pumps, three pulsometers, and one special pump, and is capable of handling 2,000 tons of water per hour, and is equipped with a large electric light plant so that salvage operations may be carried on both night and day.

In order to obtain enough satisfactory men, the company conducts a school which has been in operation for five years. This school is carried on in a handsome two-story brick building built for this especial purpose. They teach five classes of boys, in all about 250.

About fifty boys enter each year, besides 100 apprentices who are given lessons in the morning before going to work. In March, 1904, twenty-two boys graduated and entered the different departments as apprentices for a term of five years. As showing the attitude of large works to the outside public, it is interesting to note that this school is free to anyone who cares to enter.

The company has built a hospital where it maintains a corps of physicians who treat the employees of the company free of expense. They have accommodations for fifty patients at one time. The company also owns its own water supply. That the company is liberal in its treatment of employees is shown by the further fact that since 1897 they have had in operation a combined pension and insurance system. To this fund each employee makes a monthly payment, while the owners contribute an equal amount. The benefits range from 50 to 2,500 yen, according to the standing or position of the employee, and are given to the families of those who are either injured or die at the works. Those who retire from old age receive a pension. A savings bank system is also in operation. Each employee who so desires deposits one yen on each pay day, on which the company pays a liberal rate of interest. When the principal and interest reach 300 yen the company then adds 50 yen to the amount and another account is opened.

On the premises the company has erected a club house for the use of its officials and foremen. It is fitted with billiard tables and various games. Lunch and light refreshments are served at any time. A small library and reading room is supplied with reading matter, consisting mostly of engineering and naval works, text books and current technical journals. Upon the beautiful hillsides back of the works and overlooking the harbor there are about twenty official residences for such of the high class employees as care to occupy them. It will thus be seen that the company takes an interest in about everything that pertains to the welfare of its workmen.

Kawasaki Dockyard Company, Limited.—This company has extensive grounds and a lengthy water front on the west side of Kobe harbor. The city of Kobe is located near the entrance to the celebrated inland sea, on the northwest shore of Osaka Bay, and only a little south of the center of Japan's eastern coast line.

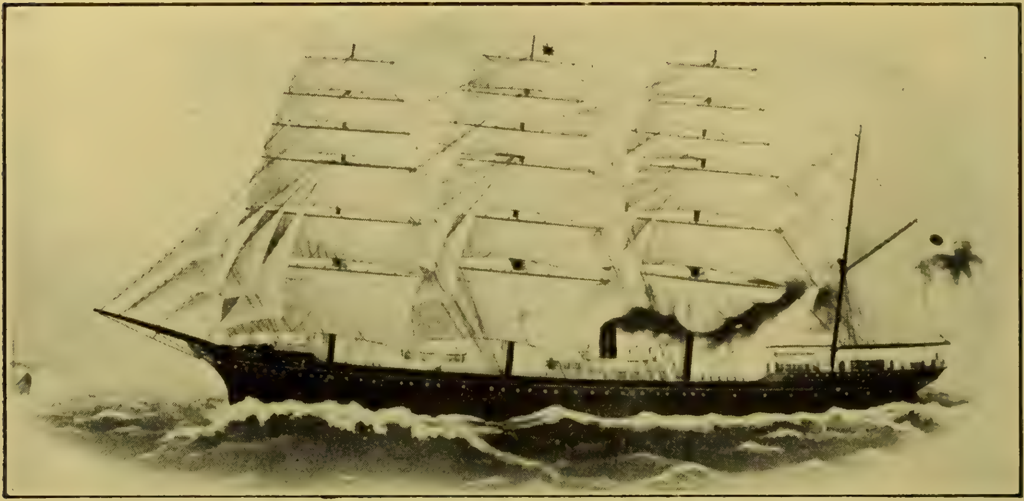
As showing the type of men who now enter ship-building and other industrial works in Japan, it is worthy of mention here to note that the president of the company, Mr. K. Matsukata, is a son of Ex-Premier Count Matsukata, the father of Japan's present financial system and who is still one of the Mikado's trusted advisers. To find a man of this type engaged in business enterprise only goes to show the immense change that has taken place in Japan within the last forty years. Previous to that time the better class Japanese would have nothing to do with business and the merchants were not looked upon with favor. At the present time the change is complete and business is an honorable profession with men of all rank. The coming of the higher class Japanese into business has brought in the much needed higher ideals as to commercial methods and honesty.

In order to keep posted on the best designs, tools and manner of working in Europe and America, the officials send every year in regular rotation one of their engineers to study what is being done. Besides this the management occasionally sends some of the executive members to study up that side of the business. The company is a thorough believer in the ability of the Japanese to do things and hence does not employ foreigners in any capacity. Like all the other large dock companies, it buys only the best material, and the management and engineers insist on turning out good work.

STEAMSHIP "CITY OF PEKIN" IN LARGE DOCK OF KAWASAKI DOCKYARD CO., LTD.

While Kobe is not the home port of any large steamship lines, yet all the steamers, both from Europe and America, including cargo and passenger steamers, make Kobe a port of call. This port has therefore the largest tonnage of any harbor in Japan and naturally the shipping interests are very large. This makes an ideal location for dockyard companies.

The Kawasaki Company is the largest in operation in Kobe at the present time, next to the largest in Japan, and is engaged in ship-building, repairing and general engineering work. The Japanese Government, being paternal in its rule, early started to establish various industries, and ship-building was one of those thus helped. As these industries developed and no longer needed governmental care, they were turned over to private companies to operate, and so it came about that this establishment was sold to Mr. Shozo Kawasaki some time in 1886, after having been started by the government in a small way during the seventies. In 1896 the present stock company was organized, taking over the whole works and capitalizing them at 2,000,000 yen, which was fully paid up. Since then they have issued, mostly taken by the original stockholders, another 2,000,000 yen, of which only part has been paid up. Although nominally a registered stock company, it is practically a close corporation, since the majority of the stock is held by a few influential men. The company regularly pays a dividend of 12 per cent. on the stock, and has issued bonds at two different times, each issue being 1,000,000 yen, bearing 9 per cent. and 7 per cent. interest.



TRAINING SHIP "TAISEI MARU," BUILT BY THE KAWASAKI DOCKYARD CO., LTD.
300 feet long; 4,300 tons. Used by Nautical College of Tokyo.

The company has nine ship-building berths and the necessary machinery for laying down and building vessels of various lengths up to 600 feet and 7,000 tons gross. It also has a splendid dry-dock, described below, and two patent slips, the larger of which is 600 feet long on the rail and will take vessels up to 280 feet long and about 2,000 tons gross, while the smaller one is 400 feet long on the rail and will take vessels up to 180 feet in length. The present and proposed buildings, of which there are an ample number for all purposes, are some of them of large size, and all the buildings now being erected are either of brick or skeleton steel frame work with galvanized roofing and sides. They are being located and arranged so they can readily be extended as the business increases.

Outside of its regular ship-building, docking and repair work, the Kawasaki Company has made boilers of various sizes and types, including eight Miyabara water-tube boilers for H. I. J. M.'s cruiser "Hashidate," marine and land engines, direct-connected centrifugal pumps, engines, tanks, steel pipe, etc. It also has in operation a special department for the manufacture of shells for the small guns of the imperial defence. It has a good sized salvage steamer built by itself, fitted with powerful electrically driven pumps, diving apparatus, derricks, and all other necessary gear. On the grounds is a small dispensary fitted with first aid appliances, while a regular physician is always within call.

The management is very progressive and the company was the first in Japan to build vessels for export. It points with pride to the pioneer export ship, the steamship "Liu Hsing," a lighthouse and buoy tender, built and engined complete for the Imperial Chinese Maritime Customs at Shanghai. This vessel is fitted with twin screws, triple-expansion engines of 1,300 indicated horse power, electric light and all other modern appliances. The gross tonnage is 750 and the speed thirteen knots. She is 185 feet long, and was completed in June, 1902. The Kawasaki Company has also built a small river gunboat for the Chinese government, a lighthouse tender, which will carry a couple of small guns, for the Korean government, and a steam launch for the Siamese government.

The growth of the works will be shown from the fact that in 1898 the tonnage of the ships launched was about 1,000, having engines of 1,200 indicated horse power, while there were employed at the works about 1,800 men. In 1902, 8,500 tons were launched, with engines of 11,000 indicated horse power, and the number of employees was about 3,500. In all they have built about fifty vessels, the largest to date being about 2,300 tons gross.

The power used throughout the works is almost entirely electrical. The larger machines throughout the works are run by individual motors, while the small ones are run in groups. The management is considering the installation of an 800-kilowatt steam turbine unit. The company has also in use what is probably the most extensive pneumatic outfit in the empire. The pneumatic plant and the various tools were imported from America, where the management sent an engineer to be thoroughly instructed in their use.

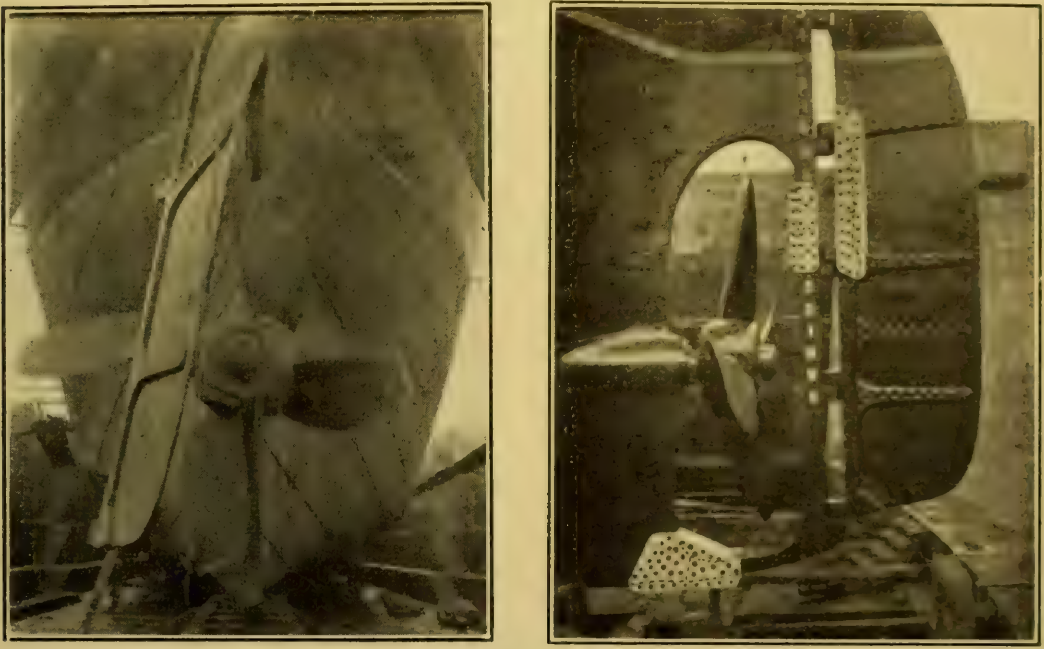
They also have a very powerful hydraulic plant for flanging, joggling and forging, which was imported from England. This was the first dockyard in the empire to install a cast-steel plant, and for some time past they have been using cast steel wherever necessity called for light weight combined with strength, such as frames for engines in torpedo boats, and have had very good success in this line of work.

To a foreigner an interesting event, which throws a side-light on Japanese labor, takes place when the works close at night and the men file out through narrow passage-ways where they are searched by inspectors before being permitted to leave the premises. This, of course, is to prevent the workmen carrying off any small articles of value which they could readily sell to junk shops.

The shipping conditions in Kobe harbor began to demand a dry-dock in the early nineties. The Kawasaki Dockyard people therefore prepared to meet this demand, and upon making an examination of the strata underlying their property, found that they would have a very difficult piece of engineering work in order to successfully build a dry-dock. Test borings showed that under the top layer of sand there was a layer of silt some 25 feet thick, beneath which were other layers, mostly sand, all evenly charged with water and evidently connected with the sea. The opinion was freely expressed among the foreign engineers living in the vicinity that the dock could never be built at the site selected. The dock was however officially opened in June, 1902, having been about five and one-half years in building. Since then it has been occupied almost continually and remains as when built as tight as a drum and as dry as a bone.

The dock complete with pumping outfit cost about $850,000. The American, German, Austrian, British and other governments have had their war vessels in this dock, which is also patronized by all the European, Australian, American and Japanese steamship lines which call at Kobe. Its dimensions are as follows: Length, caisson to toe of head wall, 426 feet; length on floor, 392 feet; width of entrance at top, 64 feet; width of entrance at bottom, 52 feet; depth of sill below high water, spring tide, 24 feet.

As illustrative of the manner in which the Imperial Government makes use of the industries in the empire which may be of assistance to it, the following is of interest: All the larger warships of the Imperial Japanese Navy have been imported, principally from England, and until lately most all of the smaller vessels were also built abroad. Torpedo boats and torpedo boat destroyers were often sent for repairs to the larger and best equipped of the private dockyard companies, which in this manner became more or less familiar with the construction of these little craft. Later on torpedo boats and torpedo boat destroyers were ordered from abroad, but were shipped knocked down to Japan, and sent with the erecting drawings to a few of the private dockyard companies, including the Kawasaki, for erection. The companies thus had the benefit of the experience obtained; first in repairing; second, in erecting the small vessels, and the third and final step was the building of these small craft themselves. This two or three of the dockyards are now doing and some of the vessels so built have seen service in the present war. By this method Japan is gradually absorbing the knowledge of other nations and taking into her own hands work of all kinds as fast as she is able to equip herself to undertake it.



STEAMSHIP "KHALIF" IN YARD OF YOKOHAMA DOCK CO., LTD.

On the left she is shown with stern frame and rudder damaged in a typhoon, and on the right, with temporary repairs, with which she steamed full speed to Cardiff, Wales.

Yokohama Dock Company, Limited.—Yokohama is situated upon the western shore of Tokyo Bay and in order to protect its shipping the government has made a good harbor by building an extensive breakwater. Within this breakwater, and upon the city's shore front, is located the Yokohama Dock Company's property, which is therefore accessible in all kinds of weather.

Before there were any graving docks in Yokohama, the old Mitsu

NO. 2 DOCK AND PUMP HOUSE OF YOKOHAMA DOCK CO., LTD., IN COURSE OF CONSTRUCTION, 1896.

Bishi Steamship Company owned a small repair works there. When the Mitsu Bishi Company was absorbed by the Nippon Yusen Kaisha in 1885, the latter of course took over the repair works, but desiring to confine their attention to their growing shipping business only, they sold the repair shops to the Yokohama Dock Company, Limited, in 1896. This yard differs from some of the others in Japan in that it was not started, and has not been assisted by the government.

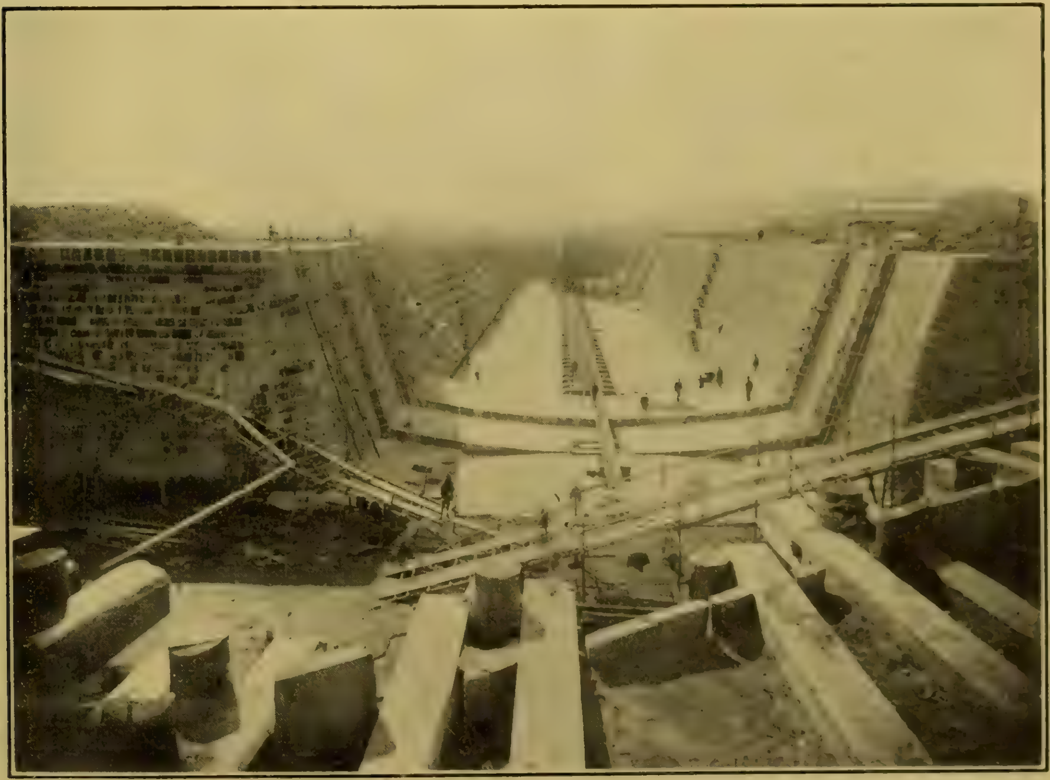
Although this company is engaged largely in doing repair work, yet it builds small towing boats, yachts and launches, lighters, land and marine boilers and engines, steel frame buildings, etc. In 1903 the company erected steel frame work amounting to 400 tons, and generally finds this class of work profitable. In 1904 there were on the premises nineteen buildings and eleven sheds, eleven of which were brick, one steel frame, and the rest stone.

Yokohama is either the terminus or home port of almost all of the many lines running from Europe and Australia via Southern Asia to China and Japan. It is also the beginning and end of all the great Nippon Yusen Kaisha's schedules with the exception of the American line. All the big and little Transpacific steamers call at Yokohama as well, so it was an excellent location for much needed docks.

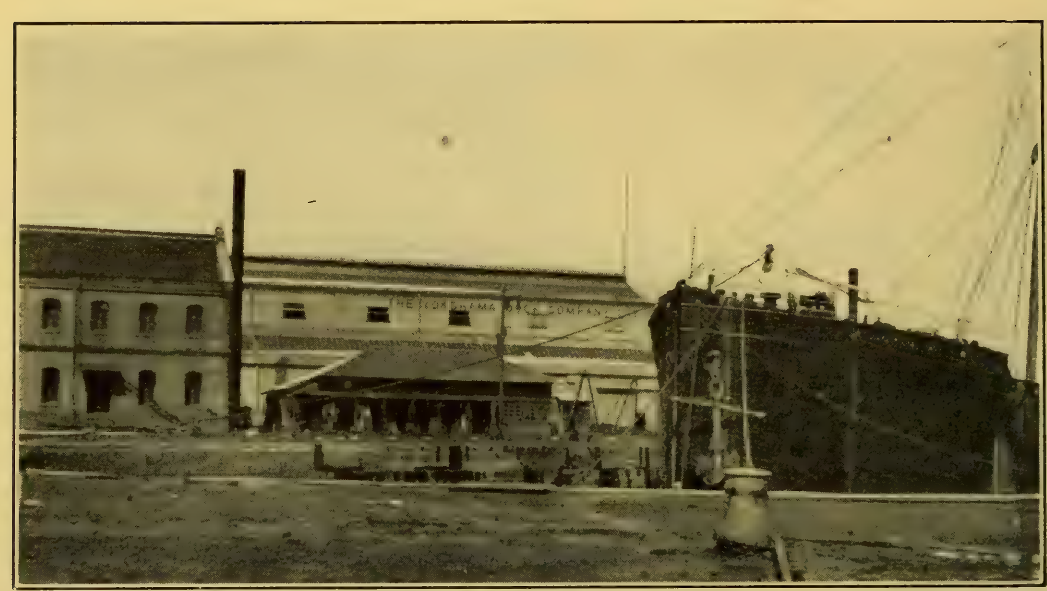
The present company started operations in 1896. Its small dock was opened in 1897 and the large dock in 1899. The works were started with the idea of docking and doing repairs only and this has been largely continued to the present time. They are the result of a desire, on the part of some of the shareholders of the Nippon Yusen Kaisha and of some influential Yokohama men, to have ample facilities for docking vessels in Yokohama. Previous to the opening of these docks the most available place for repairs in this neighborhood was at the government docks at Yokosuka, but these were available only by obtaining special permission and in case of extreme necessity.

The area of the works is 37,624 tsubo, or 1,354,464 square feet. The water front has a length of 3,104 feet. In the dredged passage or basin in front of the docks there is a depth of 36 feet at high water, but in the harbor outside the basin it is not quite so deep, although this is now being deepened. The larger part of these works was built on reclaimed land with the understanding that the property was to belong to the company when the reclaiming was properly done.

In all the company has on its pay roll about 1,000 employees, of which a fair number are apprentice boys. Usually the different grades



LARGE DOCK OF YOKOHAMA DOCK CO., LTD., COMPLETED 1899.



PART OF YARD OF YOKOHAMA DOCK CO., LTD.

of men are trained in the works, although occasionally some are obtained from the smaller yards with which Japan abounds. Probably 15 per cent. of the present help has come from other works, and a less proportion than this drifts away either to start business for themselves or to work in other shops. At this yard, as in all Japanese yards, it is difficult to secure in a hurry any exceptionally large increase in employees, although a floating number up to about 15 per cent. of the present number is usually readily secured.

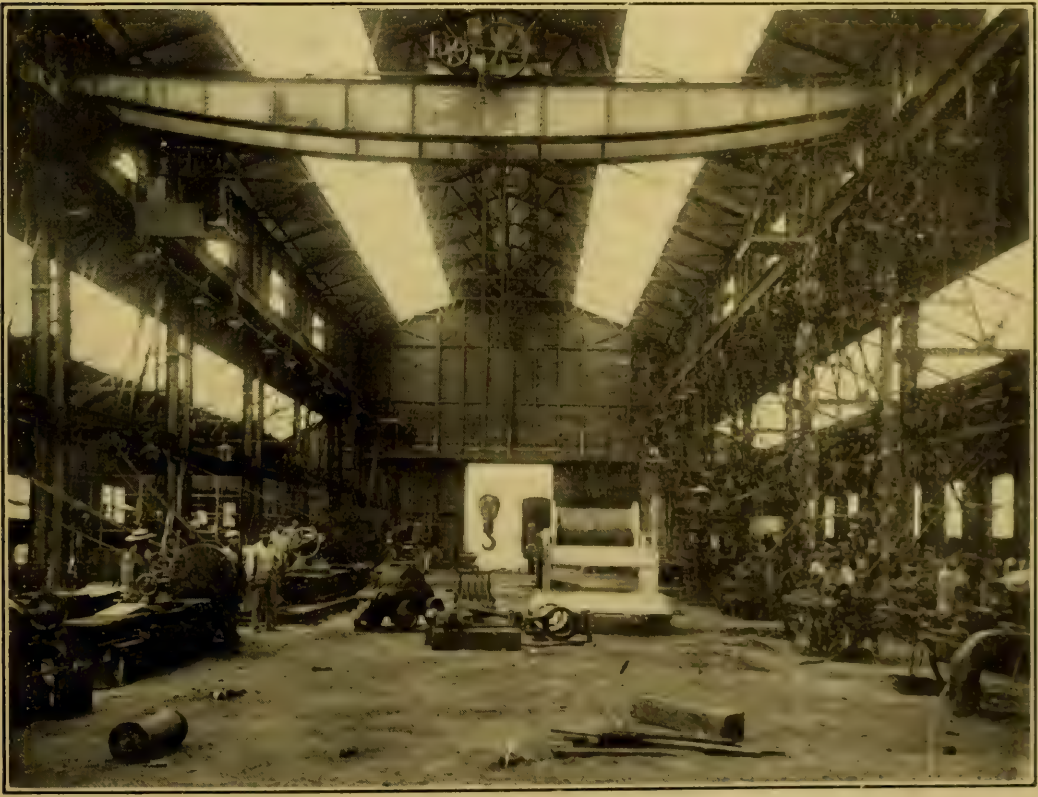
Here, as elsewhere, there are no regularly organized labor unions, but the old time customs, which are very powerful and sometimes deeply felt, have to be regarded very carefully. Ordinarily, however, the workmen are fairly just in their requests and are not troublesome. They feel that they belong to the company and to its officers. In fact one might almost say they feel that a part of the company belongs to them. Really they seem to take pride in being a part of the works, which increases with the length of their service, and this feeling is not without reason, because the men are kindly treated and seldom discharged even when work gets scarce. When once discharged there is considerable difficulty in getting them back again. Here, as everywhere and in every condition in Japan, the old feeling of master and servant still remains to an extent so much greater than in our own country that it is hardly conceivable by us.

The men show an adaptability in changing from one kind of work to another, otherwise on repair work the company would not be so successful. Those, however, who work on machine tools are kept there permanently. It is the established policy of the company to substitute labor-saving machines for hand work wherever possible, since it considers these both quicker and cheaper than the best labor obtainable, the price of which is rapidly rising.

A floating derrick of thirty-five tons capacity is in use along the water front, while a system of light railways facilitates transportation of materials among the buildings. A branch of the Imperial Government Railway runs into the yards and is connected with a system of tracks reaching all the main buildings. The buildings thus reached are served by a six-ton traveling crane.

A wet dock without gates is now in process of construction for enabling deep-draft vessels to be moored at the works. This will be built on property now owned by the company and will be 500 feet long, 160 feet wide and thirty feet deep at low water, and will take about two years to complete. The company has in operation two dry-docks and one small marine slip, which is used mainly for tugs, launches and other small craft. The larger dry-dock has an inside length of 514 feet, and the other, of 375 feet.

The largest vessels docked have been the "Inaba Maru" and



MACHINE AND FITTING SHOP OF YOKOHAMA DOCK CO., LTD.

Showing hauling winch for slipway.

other European liners of the Nippon Yusen Kaisha, these being rated at about 6,200 tons gross, and having a length of 449 feet, beam 49 feet 9 inches, and depth 30 feet, 6 inches.

Ishikawajima Shipbuilding & Engineering Co., Limited.—This company has in Tokyo a wooden graving dock, and besides shipbuilding and docking has a considerable trade outside the regular marine line of work. It has never built any large ships, but all told has launched something like 125 vessels, mostly of wood. 13,000 tons gross will cover the output. In 1902 the company amalgamated with the Uraga Dock Co., Ltd., and the combined works are now in position to build ships of large size. The Uraga property is near the entrance of Tokyo Bay and is conveniently located for the large ships making Yokohama or the smaller ones making Tokyo. There are two docks at Uraga, one having a length of 497 feet and a depth of 26 feet, and the other a length of 471 feet and a depth of 24 feet 6 inches. Either dock can be emptied in three hours. Warships belonging to the governments of the United States, Germany and Austria have been docked and repaired here. These yards have several shipbuilding berths and all the necesssary machinery for the building of large ships, besides the equipment necessary in the docking and repairing of ships.

Osaka Iron Works.—These works are located near the mouth of the Aji Kawa (Aji River) which flows through Osaka and empties into Osaka Bay through the new Osaka harbor works. The business has been gradually increased until now the works occupy about 20 acres of land, with a water front of about 2,000 feet.

Up to the present time the yards have turned out about 200 ships, a little less than two-thirds of which are very small wooden vessels, the balance being steel. In this number are included several light-draft steamers for freight and passenger service on the short and shallow Japanese rivers. Under the Subsidy Act and since 1900 the company has built, engined and launched seven steel steamships having a total of 8,000 tons gross and 7,000 horse power.

There is one 250-foot dry-dock in operation, two more are projected, and the company possesses the usual equipment for docking and ship-building, together with that required for such work as usually comes to an iron works. At the present time it is impossible to turn out large vessels, since the river is only 14 feet deep, but when the harbor works are completed the river will be dredged and the works will be equipped to build larger ships.

The company does a great deal of outside work, including cast-iron pipes for water-works, bridge and steel frame work, complete concrete making plants, and bucket dredges for the rivers and harbors of Japan having a capacity of from 100 to 400 tons per hour.

One of the peculiar features of common labor among the Japanese is the don't-care fashion in which they look upon the necessity of regular attendance at work. The Osaka Iron Works for instance can secure the daily presence of only about 90 per cent. of their employees. The other 10 per cent. think they are sick or imagine some friend is unwell, or they are off on a lark by themselves or a picnic with their families, or they are taking a comfortable loaf or perhaps have earned so much money that they of necessity must see it all spent, or they just simply and plainly want a day or two off. At any rate fully 10 per cent. are absent daily, and the idea that they are affecting adversely their employer's interests never once enters their heads. They have constitutionally and absolutely no regard for regular attendance. Such a condition would not be tolerated for an instant in this country but in Japan it cannot be helped.

Hakodate Dry-Dock Co.—This is the northernmost of the Japanese dock companies and is located at Hakodate on the southern shore of the Island of Hokkido. The works started first with a patent marine slip having rails 520 feet long, and capable of lifting vessels up to 1,400 tons gross. With the increased shipping interests in that section these facilities were inadequate and the company has recently finished a new granite dry-dock 534 feet long at the top, 82 feet wide at the top, and 72 feet wide at the bottom, with 30 feet of water on the sill at spring tide. This is not a shipbuilding company. The equipment owned is sufficient for light repairs only.

Innoshima Dry-Dock Co.—This company builds wooden junks and does ordinary repair work on medium size steamers. It is located on an island near the center of the Inland Sea and has two dry-docks cut from the solid rock. The larger dock is 357 feet long on the bottom, 50 feet wide at the top, and 44 feet wide at the bottom, with 20 feet of water on the sill at spring tide. The other dock is used for light draft inter-island trading vessels which are usually docked two at a time, and is 300 feet long.

BRASS-FOUNDRY RECORDS AND COSTS.

By H. Deighton.

THE subject of brass-foundry records and costs, though of great importance to engineers and manufacturers, is one to which comparatively little attention is usually given by them. When attempts are made to improve matters, too theoretical a view is often taken, leading to the employment of elaborate and complicated forms, which result in dissatisfaction and discouragement. Records connected with a foundry should be as few and simple as possible. Their chief objects are:—

To ensure that all metals and supplies are properly accounted for.

To regulate the production.

To obtain accurate costs of castings made.

Too often a brass foundry is untidy and uninviting, and nobody seems to take much interest in it. Everything appears in confusion. Valuable metal is scattered around covered with dust. Consistent with such conditions, the probabilities are that verbal orders prevail, and that the foreman makes whatever castings he considers are necessary or likely to be required in the near future. If an investigation were made of the quantities of rough and finished castings in stock from each pattern number, it would show excessive quantities of certain kinds on hand and few, if any, of others. An estimated cost price is taken periodically, after which castings are "said to cost" so many cents per pound, and very likely the fact is overlooked that several different alloys are made in which the value of the metal alone may vary several cents per pound.

But here and there are brass foundries kept as orderly and almost as clean as the average machine shop. From such as these only can accurate and valuable records be expected.

Instances of brass and other metals being stolen from foundries are of such frequent occurrence, that it is no unusual thing for a manufacturer to consider this as an inevitable misfortune, and to add a percentage to his costs to provide for such a contingency. However, in an orderly and systematic foundry, under a careful foreman, whose records are properly kept and supervised, there should be little danger of loss from this source.

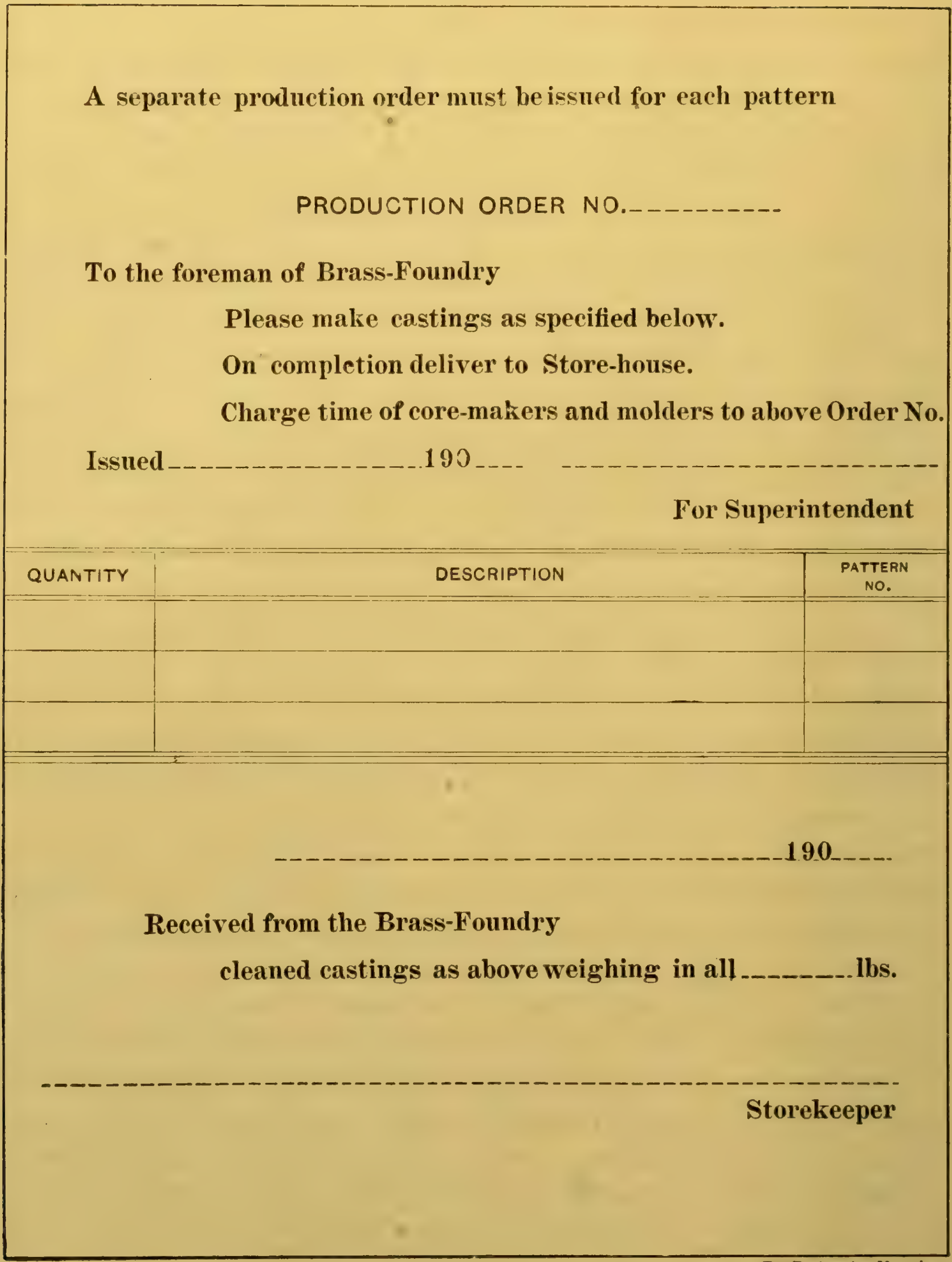
Though the foundry and machine shop are so closely allied, the methods of obtaining costs in the former differ very considerably from those pursued in the latter. In a machine shop, the exact amount of material can usually be charged up to a job immediately it is assigned, and before any work is done on it. In a foundry, however, the amount of metal for a lot of castings cannot be accurately determined till they have been made, cleaned, and weighed; which, in fact, would seem to be the only practicable way of obtaining this information. It is much more difficult to record the labor on each specific order in a foundry than in a machine shop. In many foundries the recording of this by means of time slips is not feasible. There are several different methods used in distributing the departmental burden or indirect expense in a machine shop, some of which are very arbitrary. In a foundry, however, these expenses can usually be quite equitably distributed at a rate per pound on the weight of the castings.

Perhaps the most common way followed in arriving at costs in a brass foundry—which, though very simple, is quite unscientific, and generally very inaccurate—is for the foreman to weigh and report daily the quantity of metal, fuel, and other supplies used, and also the quantity of castings produced. At the end of the month the former are summarized, priced, and extended, and added to the amount of the payroll, together with all other current operating expenses for the month. This sum divided by the number of pounds of castings produced during the month, gives the average cost per pound.

In certain cases an average price so obtained might answer the purpose. In connection with a brass foundry attached to a machine shop building similar kinds of machines containing several castings of various sizes, it would be sufficiently correct in the aggregate and not misleading; but in getting the price for any specific part, it might be altogether misleading. In the case of castings made indiscriminately for job or repair work, or for sale, such a method of obtaining costs might soon prove to be very disastrous.

Castings ought not to be made on verbal orders. There should be written production orders issued from the office for everything.

The opinion seems to prevail generally that it is hardly practicable to record the time of core makers and moulders by means of time slips. While this method does certainly fail in many cases, it is only impracticable under adverse conditions. Where the foundry is not large, or where the number of different kinds of patterns in use is limited, there should not ordinarily be much difficulty about this, provided



A separate production order must be issued for each pattern

PRODUCTION ORDER NO.__________

To the foreman of Brass-Foundry

Please make castings as specified below.

On completion deliver to Store-house.

Charge time of core-makers and molders to above Order No.

Issued________________190____ ________________________

For Superintendent

QUANTITY	DESCRIPTION	PATTERN NO.

______________________________190____

Received from the Brass-Foundry

cleaned castings as above weighing in all________lbs.

____

Storekeeper

The Engineering Magazine

PRODUCTION ORDER. ORIGINAL IS 4¾ INCHES WIDE.

the co-operation of a careful foreman be obtained. Even in large foundries, it would often pay to employ a shop clerk to look after this and other clerical work. Where the piece-work system is in force, some such records must necessarily be taken, either by means of time slips or memorandum books. One of the greatest difficulties encountered is that several different patterns are often made up in the same flask, necessitating the division of the time. In such cases, unless this is correctly distributed, the records will be of very doubtful value.

In foundries where the time of core makers and moulders cannot be recorded by means of time slips, in order to obtain specific costs recourse will have to be made to estimates. The different patterns can be divided up under "core" and "coreless" castings, and these further subdivided into say about a dozen grades known as grade "A," grade "B," &c; the grade to which each different pattern is assigned being determined by the quantity of cores per day which a core maker is ordinarily able to make, and the number of pounds of castings per day which a moulder can put up.

Metals should not be scattered around the foundry, especially such as tin and copper, which are so valuable. The stores keeper should have control of all metals and supplies (the former being kept under lock and key), and requisitions be given to him each day by the foundry foreman for whatever he draws out of store.

Gates, sprues, and other scrap metal (including castings that on account of obvious defects are condemned on the spot) should not be allowed to accumulate in the foundry, but should be melted up again as fast as possible, in preference to obtaining further metal from the store house. Care must be taken, however, that the foundry operations are not charged again with such. However, it frequently happens that a foundry foreman will report to the office the weight of these along with the weight of the new metal, thus causing himself to be charged twice, and as a consequence destroying to a great extent the value of his records for the month.

After castings have been cleaned, they should be delivered into the store house, and a receipt obtained for the exact weight, which should be charged to stores and credited to the operations of the foundry. In making up specific cost sheets, the weight of the metal used can be obtained from this receipt; it is necessary, however, to divide the weight up according to the composition of the alloy, and to add a small percentage for loss in melting due to oxidation and other causes.

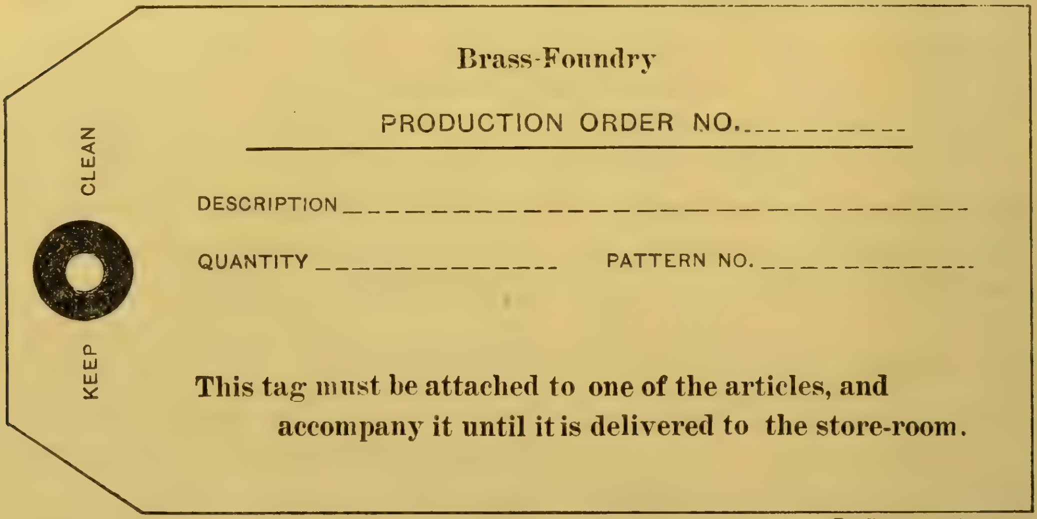
The "prime cost" of a lot of castings consists of:—

The core-makers' time.
The moulders' time.
The metal used.

The "cost of production" is obtained by adding to this its share of the indirect departmental expense at a rate per pound on the weight of the castings, which is the ratio which these expenses for a given period bear to the number of pounds of cleaned castings produced. These expenses consist of:—

Supervision, general labor, cleaning castings.
Crucibles, fuel, and other supplies consumed.
Cost of power used.
Current repairs, and other operating expenses.
Depreciation of the plant and equipment.
Proportion of general factory expenses.

Illustrations are now given of the forms used in connection with the system of a small brass foundry employing less than twenty hands. This system is very simple, and everything works quite smoothly, owing to having an intelligent foreman in charge of a superior grade of men, and also the fact that the nature of the work is such that (except in rare cases) each production order can be completed by one delivery of castings to the store house.



KEEP CLEAN

Brass-Foundry

PRODUCTION ORDER NO.__________

DESCRIPTION______________________________

QUANTITY______________ PATTERN NO.____________

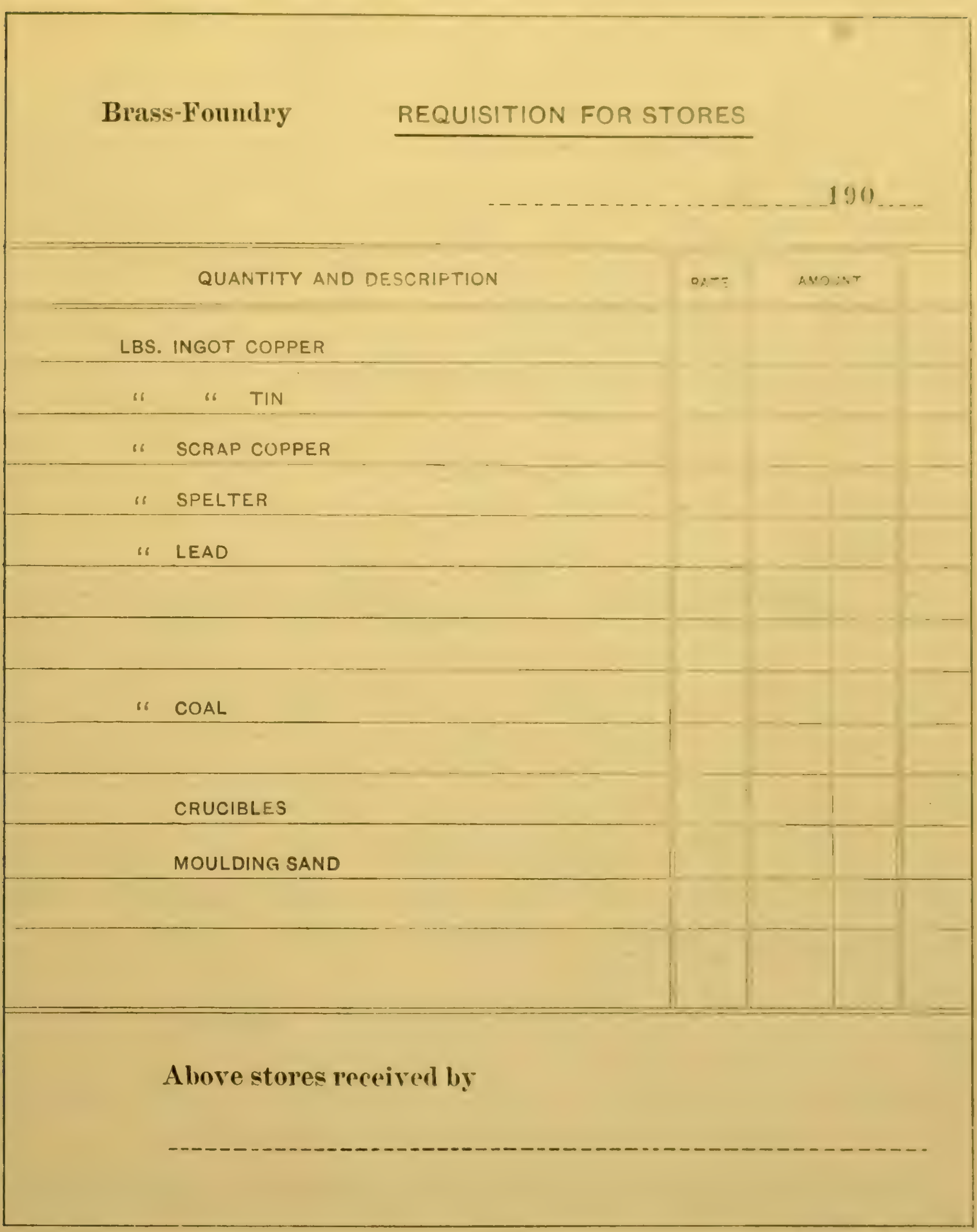
This tag must be attached to one of the articles, and accompany it until it is delivered to the store-room.

The Engineering Magazine

COURSE TAG. ORIGINAL IS 4¾ INCHES WIDE.

There are five forms in use, the first four of which only are handled in the foundry, the other (the cost sheet) being kept in the office. The forms are:—Production Order, Course Tag, Stores Requisition, Daily Time Slip, and Cost Sheet.

The production orders are consecutively numbered and issued from a carbon pad in the superintendent's office, a separate one being used for each different pattern number. At the foot of this order will be noticed a receipt, which the stores keeper signs, for the quantity and weight of cleaned castings delivered to him by the foundry. Each production order issued is accompanied by a course tag, giving



Brass-Foundry REQUISITION FOR STORES

-------------------------190----

QUANTITY AND DESCRIPTION	RATE	AMOUNT
LBS. INGOT COPPER		
" " TIN		
" SCRAP COPPER		
" SPELTER		
" LEAD		
" COAL		
CRUCIBLES		
MOULDING SAND		

Above stores received by

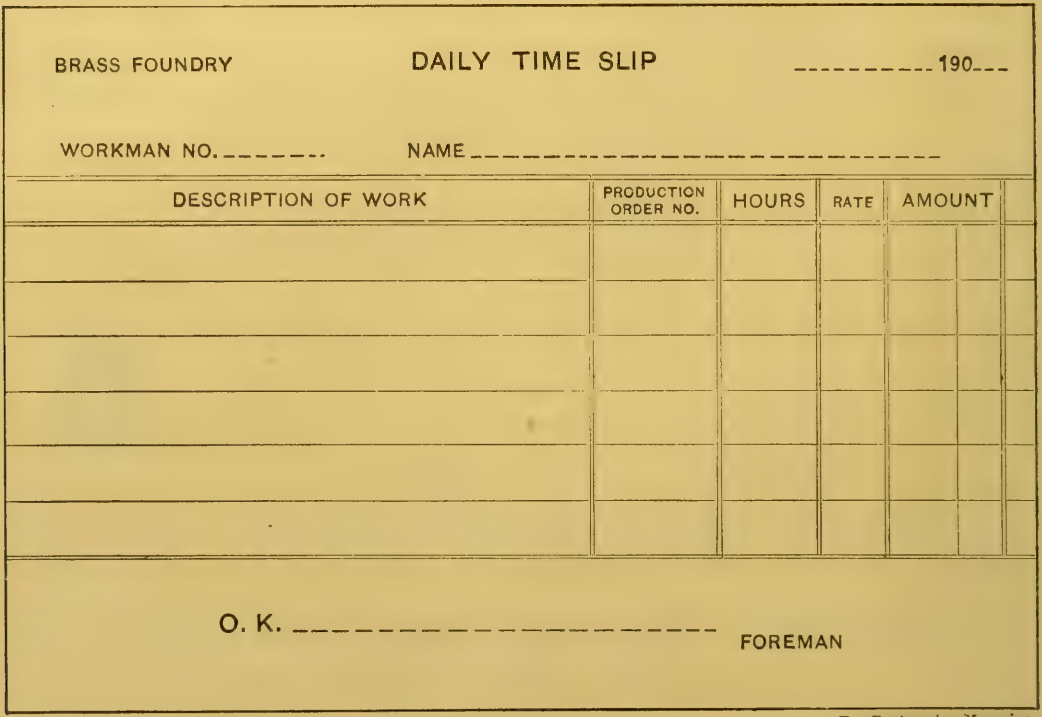
The Engineering Magazine

REQUISITION FOR STORES. ORIGINAL IS 4½ INCHES WIDE.

also the production-order number, quantity, general description of article, and pattern number; its purpose being for the instruction and guidance of the core makers and moulders and for general identification of the work.

The foundry foreman hands the stores keeper each day a stores requisition for everything he obtains from the store. These are priced and extended in the office and summarized at the end of the month, their total forming the basis of an entry in the general books as a credit to stores account and a debit to the brass-foundry operations.

The daily time slips made out by the core makers and moulders are O. K.'d by the foreman, and delivered to the office every morning. Where occasionally the patterns for two or more different production orders are made up in the same flask, the moulders divide up their time. At first the foreman attended to these cases himself, but he soon trained the men to distribute their own time. No time slips are necessary for labor in the foundry other than core making and moulding, such being an indirect departmental expense.



BRASS FOUNDRY DAILY TIME SLIP ----------190---

WORKMAN NO.------- NAME---------------------------

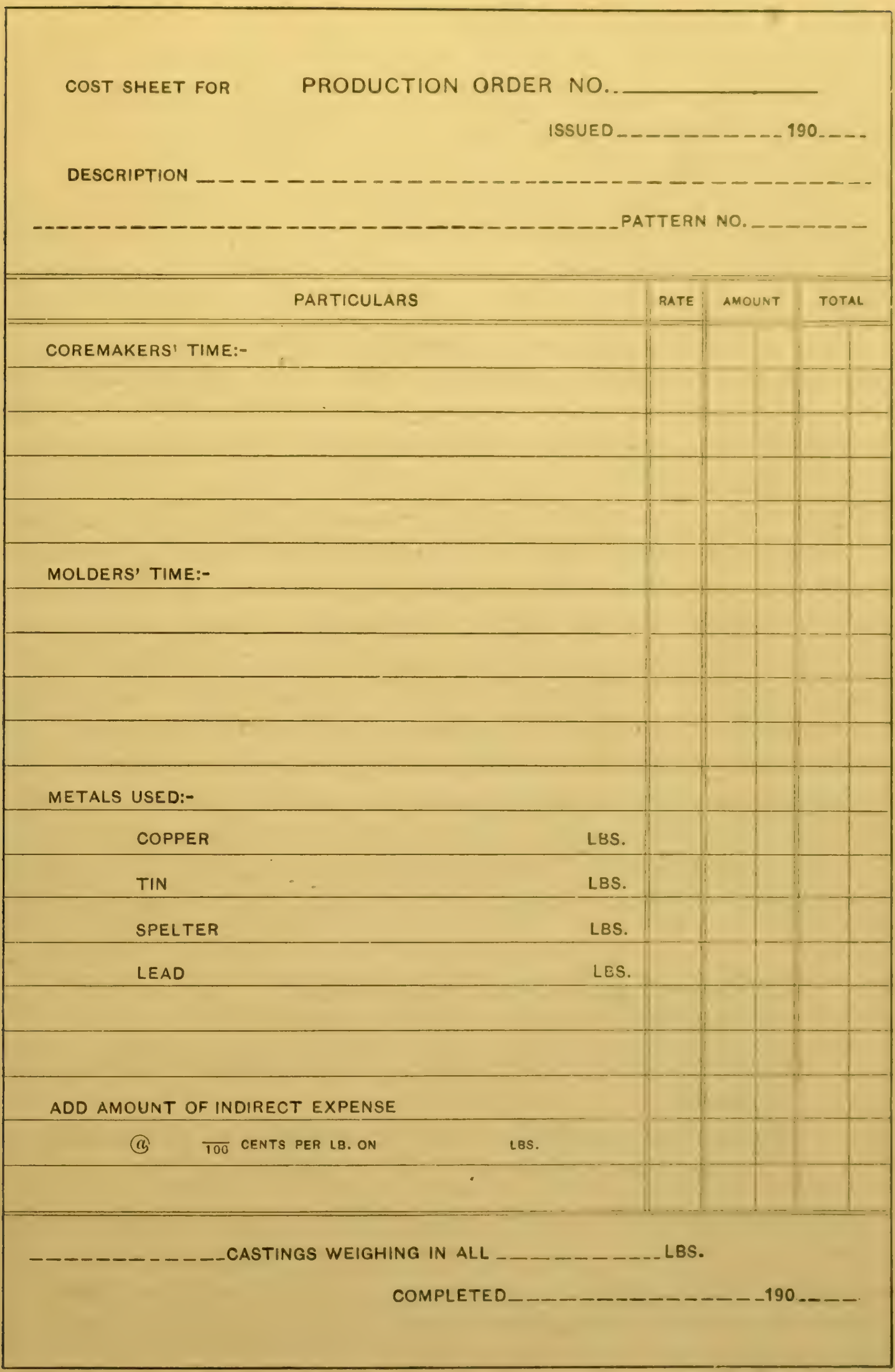
DESCRIPTION OF WORK	PRODUCTION ORDER NO.	HOURS	RATE	AMOUNT		

O. K. -------------------- FOREMAN

The Engineering Magazine

DAILY TIME SLIP. ORIGINAL IS 5½ INCHES WIDE.

A cost sheet is kept in the office with each specific production order, on which are segregated the different charges against it. To this the time of the core makers and moulders is charged from the daily time slips. The weight of metals used is obtained from the storeskeeper's receipt at foot of the production order, being the weight of the cleaned castings delivered to the store house. This has, however, to be divided up according to the different metals composing it, as, for instance, in the case of a lot of bronze castings 80 and 20 mixture weighing 265 pounds, the composition of which is 212 pounds copper and 53 pounds tin. The metal in this is charged to the cost sheet as 218.36 pounds copper, 54.59 pounds tin, which includes an increase of 3 per



COST SHEET FOR PRODUCTION ORDER NO.____________

ISSUED____________190___

DESCRIPTION ____________________________________

________________________________PATTERN NO.________

PARTICULARS	RATE	AMOUNT	TOTAL
COREMAKERS' TIME:-			
MOLDERS' TIME:-			
METALS USED:-			
COPPER LBS.			
TIN LBS.			
SPELTER LBS.			
LEAD LBS.			
ADD AMOUNT OF INDIRECT EXPENSE			
@ $\frac{}{100}$ CENTS PER LB. ON LBS.			

____________CASTINGS WEIGHING IN ALL ____________LBS.

COMPLETED________________190____

The Engineering Magazine

COST SHEET. REDUCED SIZE.

cent. to provide for loss in melting. Before closing the cost sheet, there is added to this "prime cost" its proportion of the indirect expense as a rate per pound on the weight of the castings. While this rate is changed occasionally, it fluctuates in the neighborhood of two cents per pound.

In the office, the cost sheets closed during each month are summarized, the total forming the basis of an entry in the general books as a debit to stores account and a credit to the brass foundry operations.

The production order in use here acts both as a production order and also as a receipt for castings delivered to the stores keeper; this is rendered practicable by conditions which permit each order to be completed by one delivery to the store house; in the few rare cases where this cannot be done, the production orders are recalled and closed, and new ones—bearing new numbers—issued for the balance.

At the end of each month a comparative general monthly manufacturing account is made up showing the operations of the foundry. This is credited with the number of pounds and value (as per summary of closed cost sheets) of castings delivered into the store house, and charged with the quantity and value of metals, fuel, crucibles, and other supplies drawn out of the store house, also with the direct and indirect labor as per the pay roll, and all other indirect expense. An adjustment has of course to be made here of the difference in quantity and value between any small inventory of metals and supplies, etc., that may be on hand in the foundry at the beginning and end of each month, which is, however, only trivial. This monthly account shows:—

Whether the specific costs appear correct.
The percentage of metal lost in melting.
The quantity and cost of fuel per 100 pounds of castings produced.
The cost of crucibles and other supplies per 100 pounds of castings produced, etc.

Being printed and ruled in tabular form so as to last for twelve months, and provided with columns for percentages as well as for quantities and amounts, the effects of any variations from month to month are clearly shown up here, so that their causes can be promptly investigated.

THE MECHANICAL FEATURES OF THE INTERNATIONAL EXPOSITION AT LIÉGE.

By Léon Ramakers.

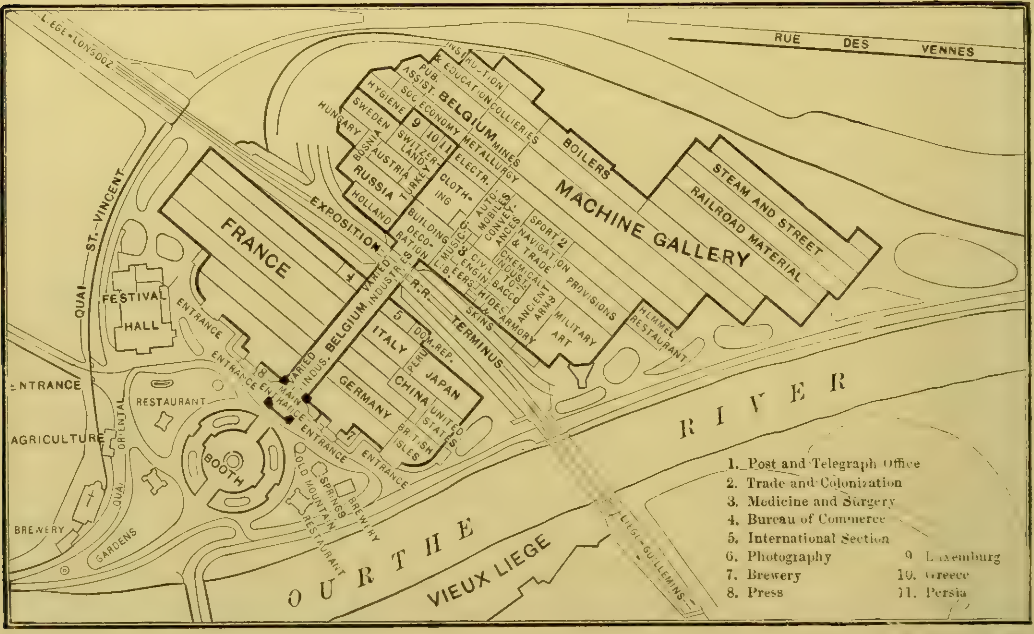
Each exposition, whether its scope be wide or narrow, is necessarily influenced by its environment, and so we find that the Liége Exposition, held in the heart of an active industrial region, is especially strong in its mechanical, mining and metallurgical features, which show the most recent advances and best modern practice of European engineers, an account of which, therefore, will be found of real interest and value.—THE EDITORS.

BELGIUM, although one of the smallest countries of Europe, is in the front rank industrially, and with her active population, the densest in the world, her great coal and iron trade and her many manufactures she possesses an importance entirely disproportionate to her superficial area. After the close of the Napoleonic wars, she was for a time linked with Holland under the same government, but a racial and religious incompatibility between the Belgians and the Hollanders led to a severance of their union in 1830. Since then each country has gone about its business in its own way, and both have progressed and prospered.

In order to celebrate the seventy-fifth anniversary of their independence the Belgians decided to have an international exposition this year and to hold it at Liége, the capital of the Walloon district. This city was chosen because it is practically the industrial metropolis of the country. Liége and the surrounding territory have been for centuries one of the world's greatest centers of industrial activity, being particularly celebrated for the manufacture of arms and weapons, and at the present day the coal mines, the iron and steel works and the manufacturing establishments of all kinds combine to give this region an international fame. Liége is also an important railroad center and lies within a few hours' journey of London, Paris and Rhenish Westphalia, besides all of Belgium and Holland, so that it has a very large number of possible visitors within easy reach, a most important consideration for an exposition city, and it has convenient access to many celebrated pleasure resorts, from Ostend to the Forest of Arden.

The exposition, which has been open during the past summer, is situated in the southeastern suburbs of Liége, just at the confluence of the Ourthe River with the Meuse. The largest and most important section of the exposition is on the right bank of the Ourthe, and comprises the Halls of Manufactures and of Commerce and some other buildings, which contain manufacturing, engineering and machinery exhibits. The fine arts buidings and the building for the display of laces, in the manufacture of which Belgium occupies such a leading position, are in a park on an island between the rivers; the agricultural exhibits and the amusement section of the fair are on the left bank of the Meuse, and a historical show, "Old Liége," is situated on the point of land where the rivers join. The total area of the exposition grounds is about one hundred and fifty acres.

Thirty-two foreign nations are represented at the Liége Exposition, most of which have special sections in the main buildings, while others, such as Canada, Norway, Morocco, Servia, Bulgaria and Montenegro, have their own pavilions in the park on the island above mentioned. The most interesting foreign exhibits are those of France, Germany and Canada, while the other nations make a showing in general accord with the extent of their territory, their degree of civilization and their economic importance, with a few exceptions.



BORMAY & CO.' N.Y.

PLAN OF MAIN BUILDINGS, LIÉGE EXPOSITION.

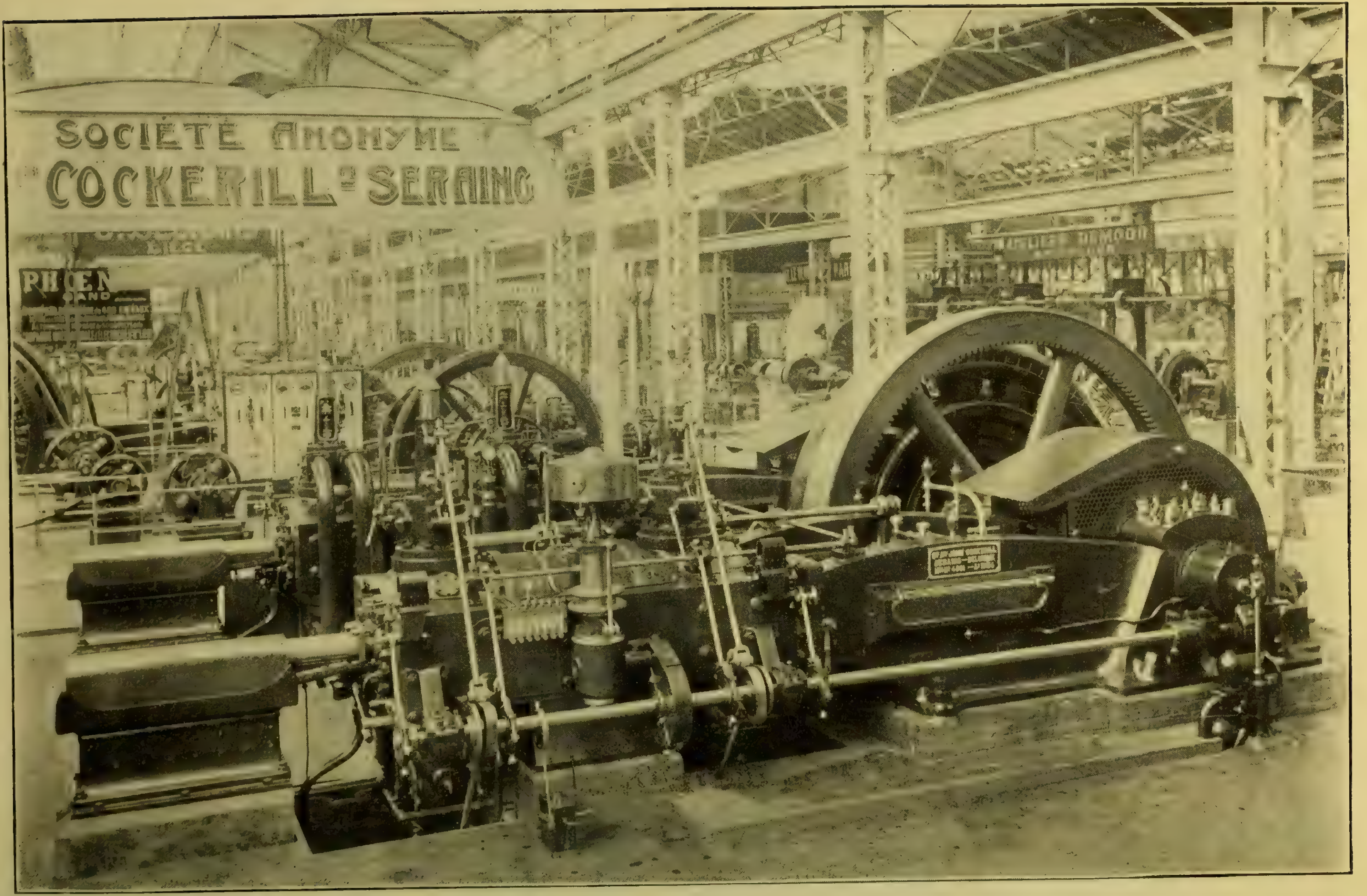
The art palaces, the lace building, and other structures, are on an island in the rivers and on the opposite bank of the Meuse River. The top of the plan is toward the east.

The main buildings, that is to say the Halls of Manufactures and of Commerce, cover an area of about one hundred and twenty thousand square yards and are intersected near their middle by the line of the Northern Belgian Railway. Their principal façade, constructed entirely of wood and staff, is flanked by two towers, one of which is used for wireless telegraphy, and is characterized by a monumental entrance in "modern style," having an imposing archway with square columns at the four corners and surmounted by a square tower crowned with statues.

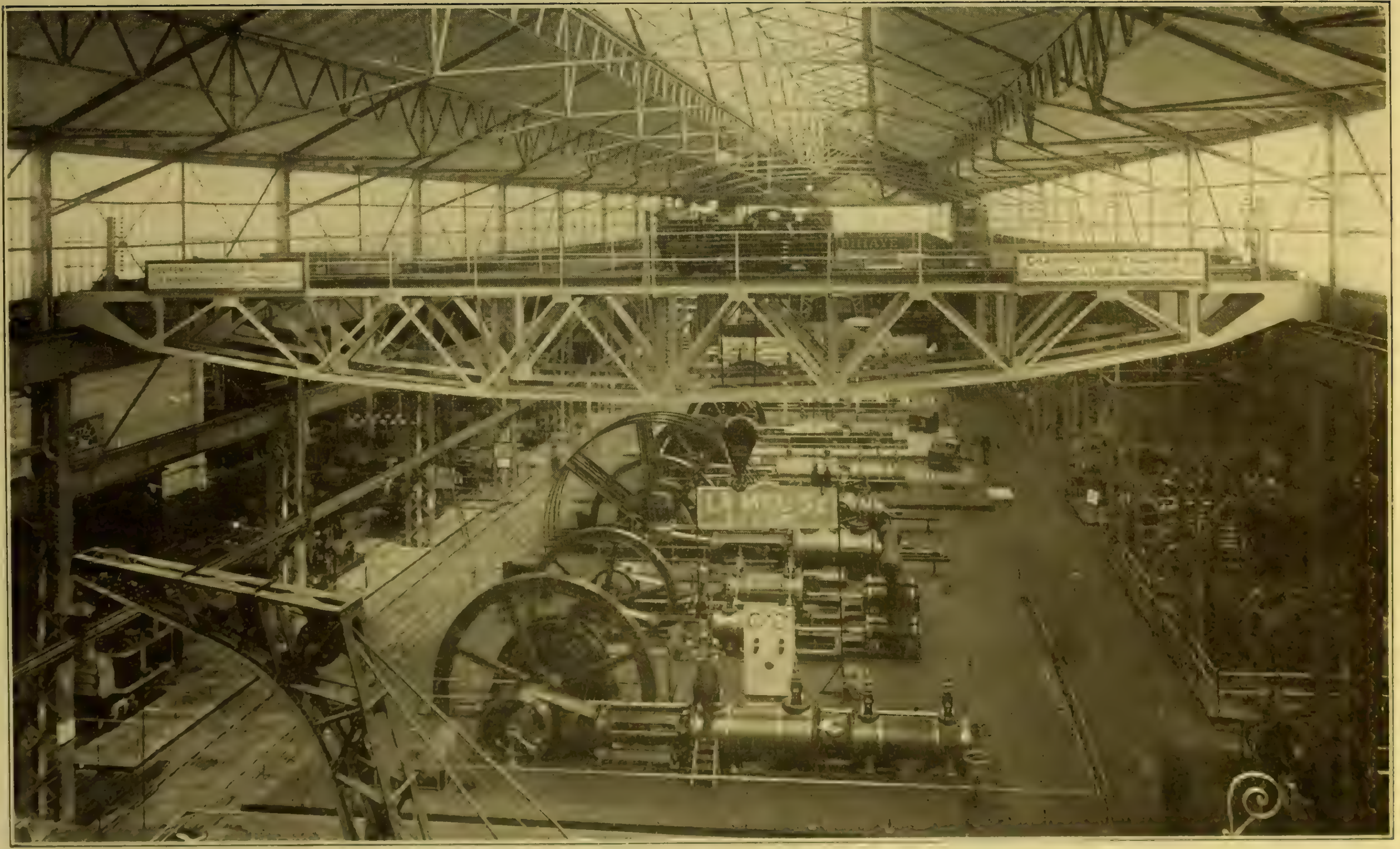
The main buildings have saw-tooth roofs, with zinc and glass roofing. The steel roof trusses are supported by latticed and sectional-steel columns, which rest on concrete piers, and the steel work is designed so that it can be used for other purposes at the close of the exposition.

The machinery halls, which form the rear portion of the main group of buildings, are constructed with bays alternating in span between forty-nine and eighty-two feet and, together with the boiler house, gas producers and railway exhibits, cover an area of over thirty-five thousand square yards, of which Belgium occupies more than half, France a sixth and Germany a little less. Besides this there are mechanical, electrical and mining and metallurgical sections covering an area of about six thousand square yards in the Hall of Manufactures. The machinery building is served by eight traveling cranes, four of which have spans of eighty-two feet and capacities of thirty tons each, the other four being of smaller dimensions. The larger cranes were built by the Société Cockerill, the Société le Titan Anversois, the Compagnie Internationale d'Electricité of Liége, and the Société Stuckenholz, and the others by the Société Gilain, the Société Cockerill, M. Gustin fils and the Société Westinghouse.

PRINCIPAL ENTRANCE OF THE MAIN BUILDINGS, LIÉGE EXPOSITION.



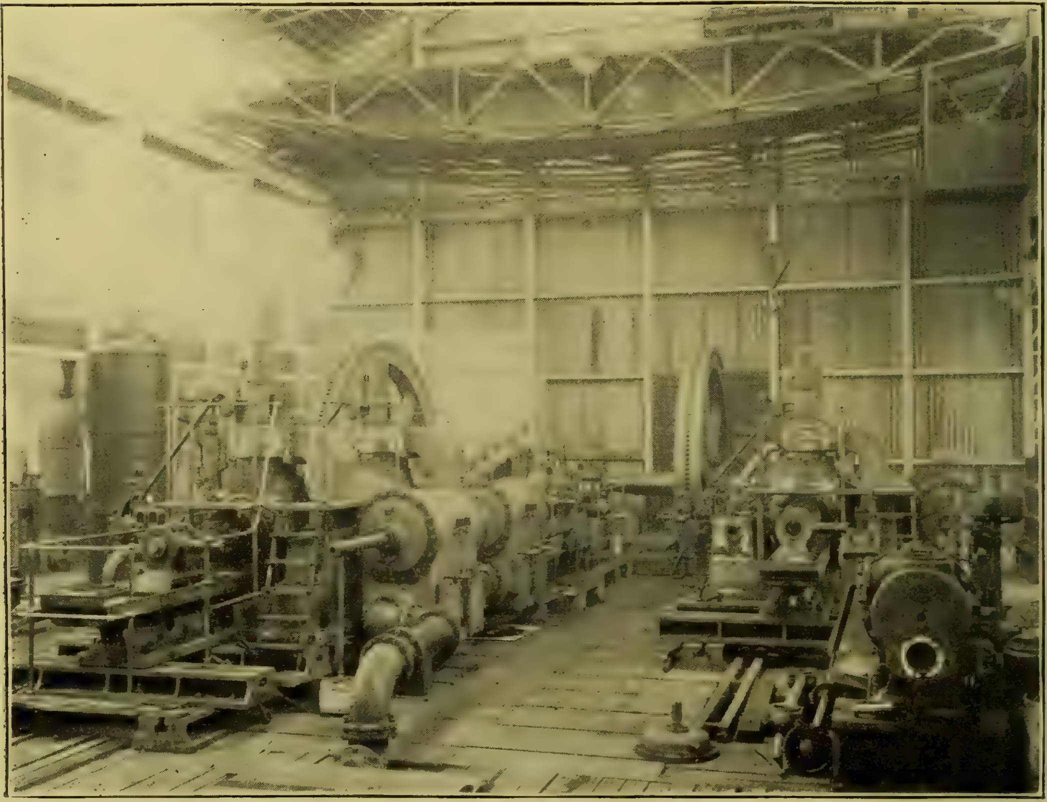
500-HORSE-POWER, FOUR-CYCLE, DOUBLE-ACTING COKE-OVEN-GAS ENGINE.
Société Anonyme John Cockerill, of Seraing.



ONE OF THE WIDE BAYS OF THE MACHINERY BUILDING.

The large traveling crane, with a capacity of 30 tons and a span of 82 feet, was equipped electrically by the Compagnie Internationale d'Electricité, of Liége.

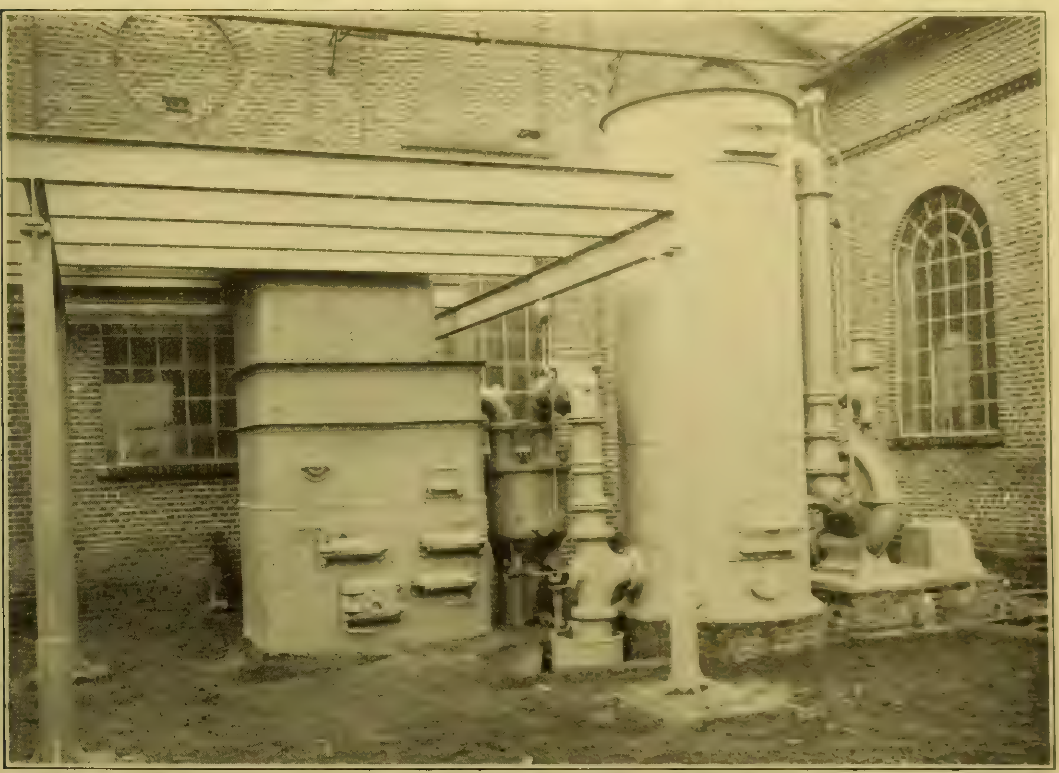
Nineteen boilers, of eight different types, are placed under cover at the rear of the Belgian machinery section. Close by are three gas producers. The water required for the boilers and for other purposes at the exposition is taken from the Ourthe River at a point above the city and distributed by a new system of mains and pipes. Steam is furnished to the engines at a pressure of 135 pounds per square inch. The regular electric current supply for lighting and power is distributed by a three-wire, direct-current system, with 440 volts between the outer conductors. This current is generated by three sets, of 750 horse-power apiece, each composed of a reciprocating steam engine and a dynamo, and built, respectively, by Carels, by Van den Kerchhove and by Preud'homme-Prion. The French section generates its own current and distributes it at 3,000 volts alternating and at 120 or 150 volts direct. The city furnishes gas for lighting and power, and the internal combustion engines also use producer gas and gasoline. There is no central condensing plant, each exhibitor fitting up his own condenser to suit his requirements.



600-HORSE-POWER, TWO-CYCLE, DOUBLE-ACTING, BLAST-FURNACE-GAS ENGINE.
Société de St. Léonard, of Liége.

As the Liége district is the seat of such thriving coal and iron industries, it is but natural that mining and metallurgy and their allied interests should play a leading part at the exposition, and there is, in fact, an excellent display of mining machinery and metallurgical appliances.

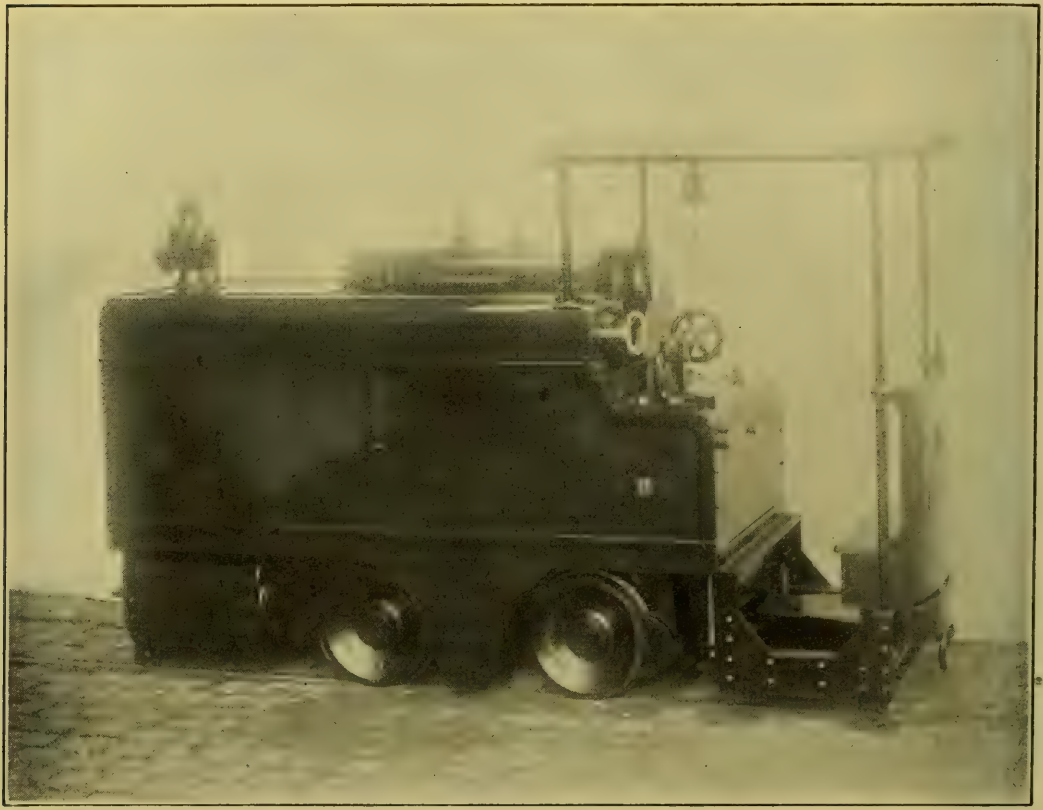
The well-known Cockerill Works, of Seraing, close by Liége, have one of the largest and most striking exhibits. They were among the pioneers in the construction of large gas engines for operation with blast furnace gas, and their engines are now in very extensive use. One of their most recent types is exhibited, a 1,200 horse power, four-cycle, double-acting, horizontal tandem engine, which is run at 100 revolutions per minute, and whose two cylinders have each a diameter of thirty-nine and three-eighths inches, with a stroke of forty-three and five-sixths inches. This engine is to be used for the direct driving of a rolling mill at their own works. Another gas engine which they show is a 500-horse-power four-cycle, double-acting, twin-cylinder one, for coke-oven gas fuel. This also is to be used at the Seraing works, in the electric power plant. A second blast-furnace gas engine is of 150 horse power; this is a high-speed vertical engine, running at 250 revolutions per minute. The latter two engines are operated at the exposition with illuminating gas and drive electric generators, whose current serves to turn over, for exhibition



250-HORSE-POWER GAS PRODUCER USING LIGNITE BRIQUETTES.
Deutz Gasmotoren Fabrik, Cologne-Deutz.

purposes, a Cockerill 10,000-horse-power, triple-expansion, reversible steam engine, with six cylinders, for use at the Seraing rolling mills.

Another Cockerill exhibit is a solid forged steel propeller shaft 169 feet 8 inches long, with a weight of forty tons, and a diameter tapering from 13.9 inches to 11.8 inches. For comparison it may be stated that the Krupp steel shaft at the Düsseldorf Exposition, in 1902, had a length of 147 feet, 8 inches, and a diameter of 21.3 inches, and was, moreover, hollow. The Cockerill Works also show a powerful six-coupled compound locomotive, with Walschaert valve gear, designed for hauling loads of 350 tons at 63 miles an hour, compound steam engines and air compressors, crank shafts, locomotive wheels models of blast furnaces, coal mines and coke ovens, and a number of other objects which make a powerful impression of the magnitude and variety of their productions.

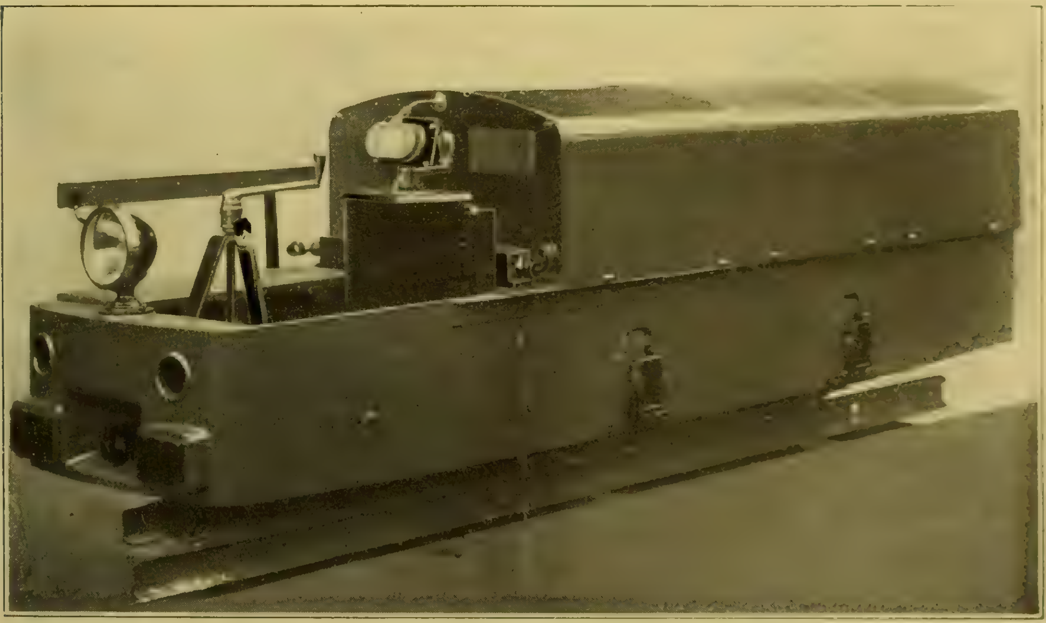


EIGHT-HORSE-POWER BENZINE MINE LOCOMOTIVE.

Deutz Gasmotoren Fabrik, Cologne-Deutz.

Gas engines are also shown by other companies, the exhibit of the Sociéte Saint Léonard of Liége, which includes a 600-horse-power, two-cycle, double-acting engine for blast-furnace gas, and several smaller ones of the Koerting type being noteworthy. These engines, while at the exposition, are supplied with gas by a producer shown by Fichet and Heurtey, of Paris, of the double-combustion form, which is suited for burning cheap fuels.

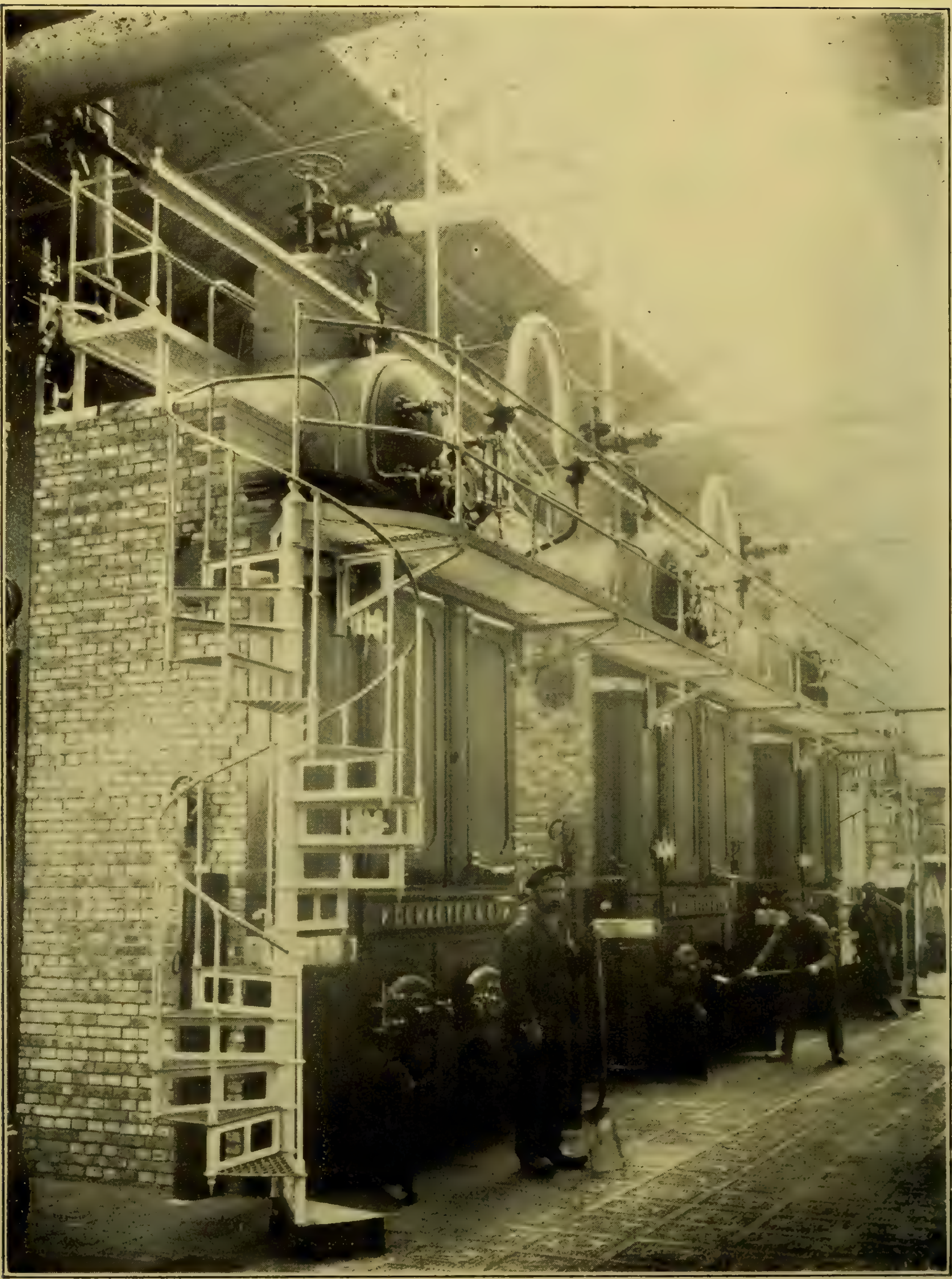
Another gas producer, of a novel type, is exhibited by the Deutz Gas Engine Works, of Cologne-Deutz, the fuel for which is briquettes of lignite, or brown coal. In this exhibit there are also gas engines, one of 250-horse-power, and one of 50-horse-power, supplied with fuel by this producer, as well as other internal-combusion motors and an anthracite suction gas producer, and an 8-horse-power mine locomotive with a benzine motor. A mine locomotive of a different kind is shown by the Société Electricité et Hydraulique, of Charleroi. This is an electric locomotive, equipped with storage batteries, and driven by two 6-horse-power motors.



ELECTRIC-STORAGE-BATTERY MINE LOCOMOTIVE.
Société Electricité et Hydraulique, of Charleroi, Belgium.

Large winding engines, steam driven, are in the stands of the J. J. Gilain Company, of Tirlemont, Belgium, and the Meuse Works of Liége. The Gilain engine can lift a load of ten tons from a depth of 5,000 feet at a mean speed of 46 feet per second, while the Meuse engine has a somewhat smaller capacity, but both are fitted very completely with safety appliances. The Meuse Works also exhibit a gasoline portable engine, which can drive a dynamo or do other work, and is a very handy machine.

Among the traveling cranes which command the different bays of the Machinery Building, the most interesting, perhaps, is that built by the J. J. Gilain Company, as it is the only one equipped with alter-

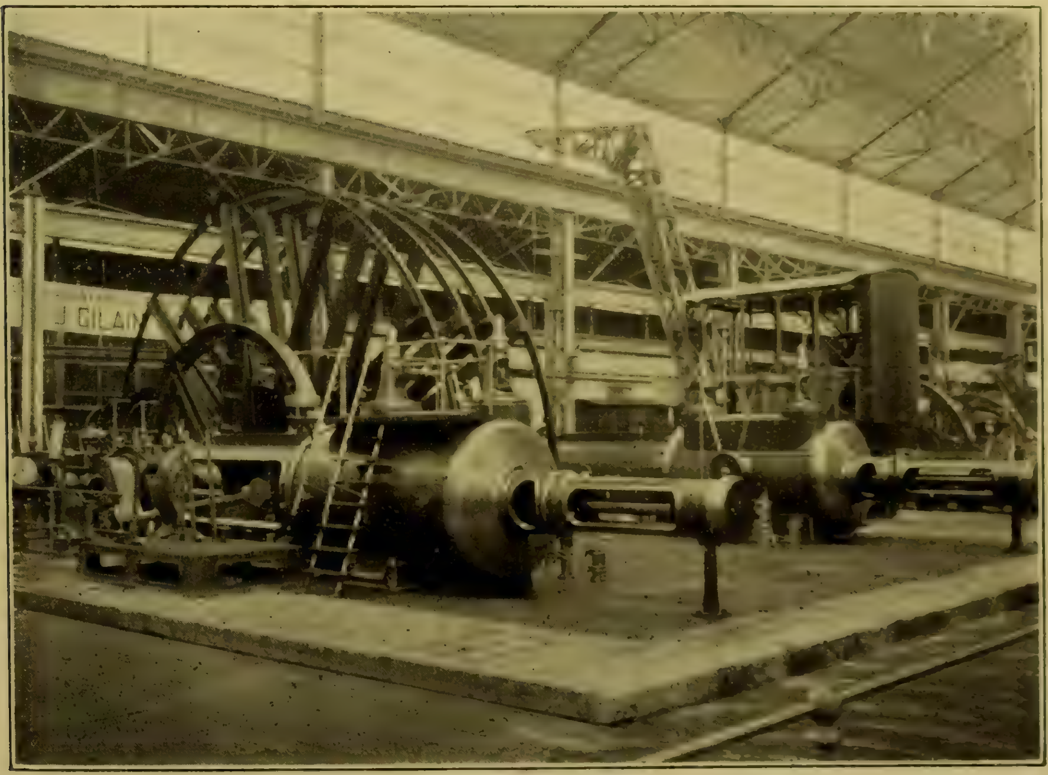


WATER-TUBE BOILERS AND STEAM SUPERHEATERS.
Vve L. De Naeyer & Cie., of Willebroeck, Belgium.

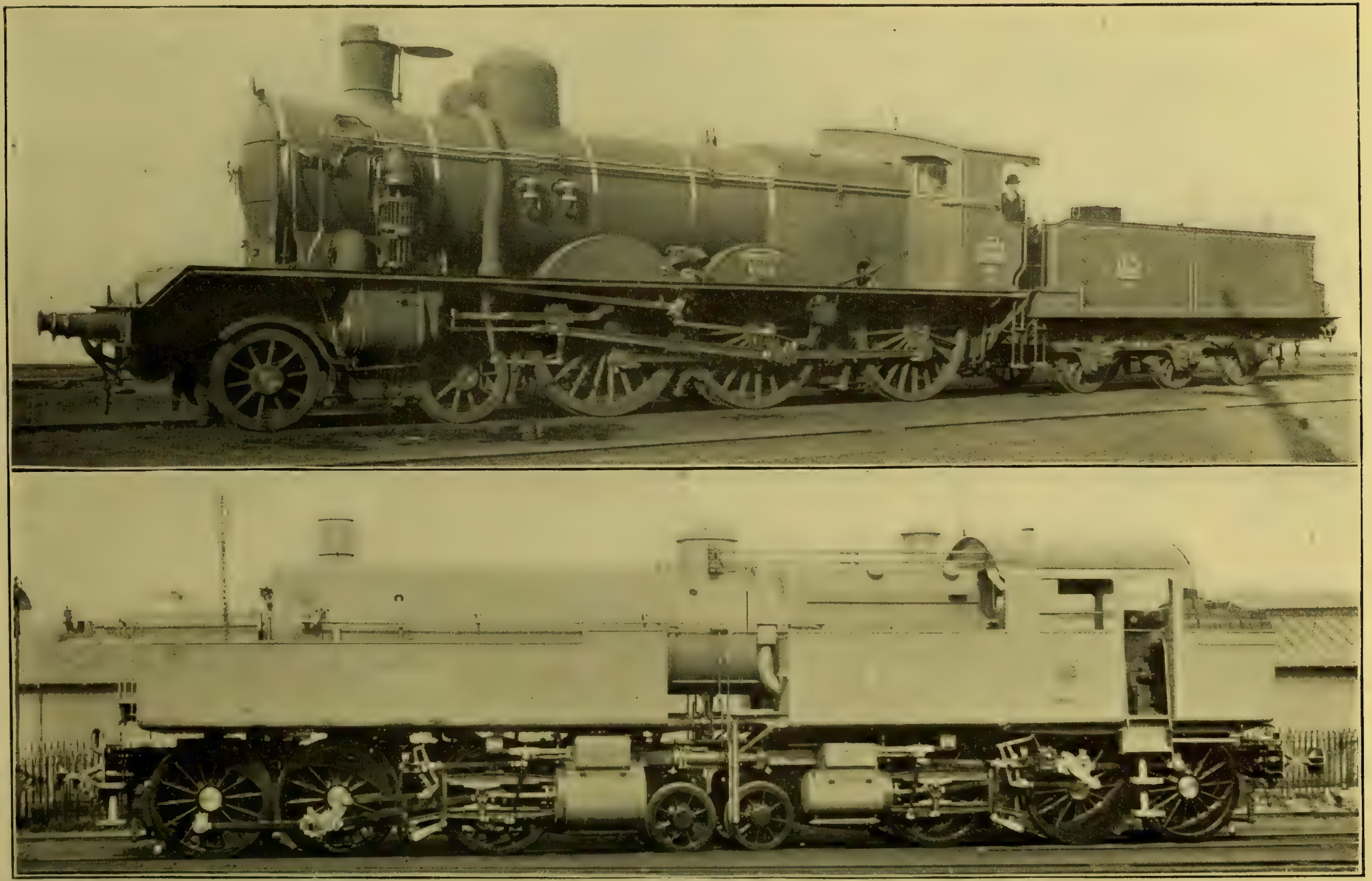
nating-current motors. It has a span of forty-six feet eight inches and a capacity of ten tons, and its speeds per minute are: hoisting, twenty feet; trolley travel, ninety-eight feet; bridge travel, 262 feet. One of the largest cranes in the building and one which was of great service in erecting the machinery, is that of the Compagnie Internationale d'Electricité, of Liége, with a span of eighty-two feet, and having two hooks, one with a capacity of thirty tons and a hosting speed of eight feet per minute, and the other of six tons capacity and a speed of thirty-six feet. Its trolley travel is 171 feet, and the bridge travel, 164 feet per minute.

Locomotives are well represented by some fine engines, shown, among others, by the Northern Railway of France, the Paris-Lyons-Mediterranean Railway, the Cockerill Works, and the Meuse Works. The Northern Railway exhibit is an articulated compound locomotive, with four cylinders, and twelve driving wheels, in two independent sets of six. It has also two pony trucks, in the middle, making sixteen wheels in all, and has a length of over 40 feet. It can haul 1000 tons up a 1.2 per cent. grade at a speed of nearly fourteen miles an hour, and on the level at from forty-seven to fifty miles. The Paris-Lyons-Mediterranean locomotive is one of twenty recently ordered of Schneider & Cie., of Creusot, and is designed for high-speed work. It is a four-cylinder, compound engine, and has six drivers and a four-wheel bogie truck forward.

The Deutsch-Oesterreichische Mannesmannröhren Werke, of Düsseldorf, exhibit a very interesting locomotive boiler, equipped with a



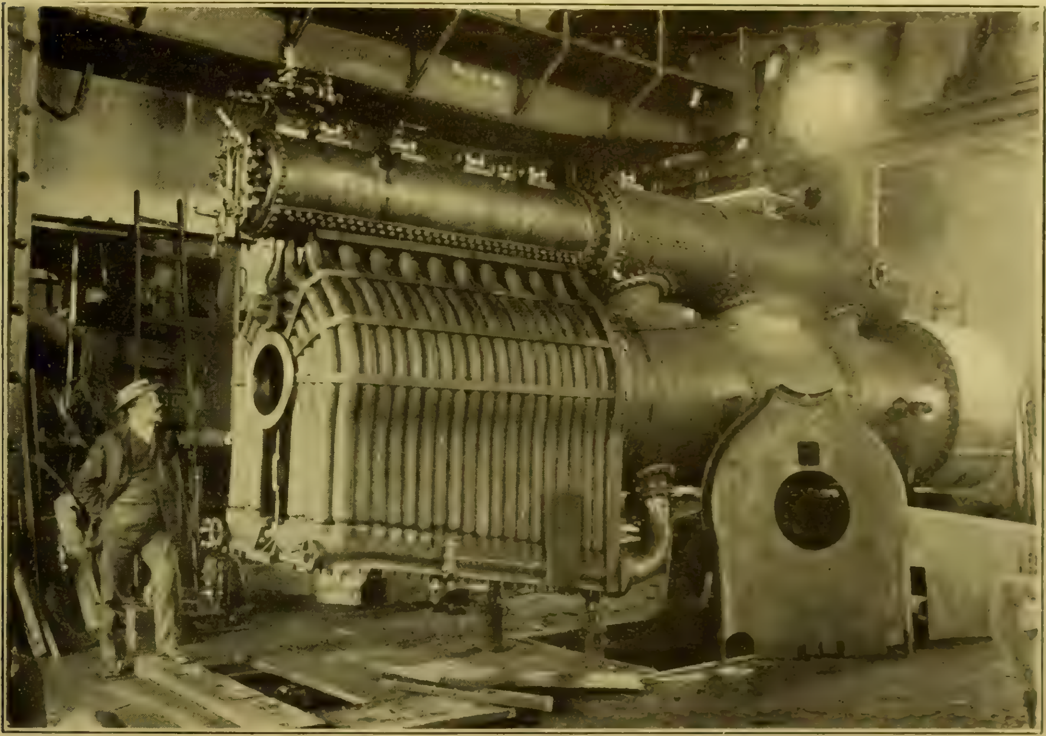
DOUBLE HORIZONTAL WINDING ENGINE.
Société Anonyme J. J. Gilain, Tirlemont, Belgium.



NEW FRENCH PASSENGER AND FREIGHT LOCOMOTIVES.

The upper one is a six-coupled, high-speed engine, built by Schneider & Cie., Creusot, and exhibited by the Paris–Lyons–Mediterranean Railway. The lower one is an articulated locomotive shown by the Northern Railway of France.

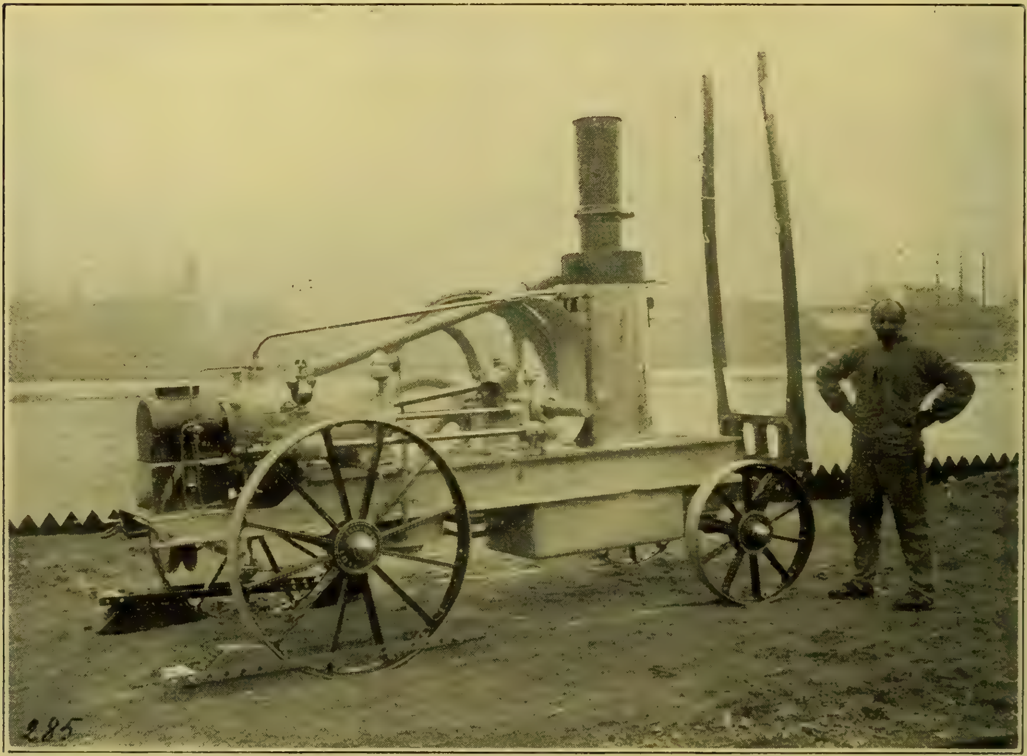
Brotan water-tube fire-box. The defects inherent in the usual types of fire-box are here remedied radically by forming the sides and rear of Mannesmann seamless steel tubes, arranged with an interval of less than one-tenth of an inch between them. Their lower ends are rolled into a cast-steel pipe, and their upper ends into the rear portion of a second boiler lying above the main fire-tube boiler and projecting toward the rear. This second boiler carries the steam dome and is connected to the fire-tube boiler by means of three necks. From the fire-box, the gases of combustion pass forward through the tube plate into the fire tubes of the main boiler. This fire-box, which is covered with a sheet-metal jacket that can be removed piecewise, makes the boiler a combined fire-tube and water-tube one, and, in addition to increasing its strength and permitting the use of higher steam pressures, enables steam to be generated more quickly and economically.



"BROTAN" WATER-TUBE FIRE-BOX FOR LOCOMOTIVES.
Deutsch–Oesterreichische Mannesmannröhren Werke, Düsseldorf.

Among the boilers which form a working exhibit at Liége, may be mentioned two Galloway boilers and three water-tube boilers, the latter provided with feed-water heaters and steam superheaters, built by Vve. L. De Naeyer & Cie., of Willebroeck, Belgium; one from the Jacques Piedboeuf Works, of Jupille-lez-Liége, made in two parts, the lower having furnace flues and the upper fire-tubes, an arrangement providing a large heating surface in small space; a Niclausse water-tube boiler; and a Babcock & Wilcox boiler, remarkable for its large size and its sectional construction throughout in forged steel.

There are many more mechanical and engineering exhibits of great interest, which the limitations of space prevent describing, such as the well-known Green economizer; mine pumps shown by Otto Schwade & Company, of Erfurt, Germany; Corliss compound steam engines built by the Phœnix Company, of Ghent; steam engines for driving electric generators, from the Breda Works, in Holland, and the Van den Kerchhove Works at Ghent; a rotary engine which can be operated with gas, steam, oil and other mediums, shown by the Fortunesco Motor Co., of Cologne; and a great variety of others.



GASOLINE PORTABLE ENGINE.
Ateliers de Construction de la Meuse, of Liége.

Turning to another side of the exposition, the art palaces, the lace building and the other structures in the park on the island contain a great deal that is pleasing and of interest, and are very ornamental in themselves. An amusement section is also provided, and the exposition is expected to prove financially profitable, besides being, as it is, a great success from the industrial, engineering and artistic standpoints.

MODERN POWER-PLANT DESIGN AND ECONOMICS.

By Franz Koester.

In the preceding portions of Mr. Koester's paper, which appeared in the August and September issues of this magazine, he discussed first the general aspects of the design of large power stations, and afterwards the coal handling machinery, the boilers and steam piping and other features of the steam generating plant. In the present section he takes up the prime movers and compares the steam turbine with the reciprocating engine, and also treats of the condensers and other auxiliaries. The concluding portion will be devoted to the electric features of the plant.—The Editors.

VIII. STEAM ENGINES.

THE time has passed when a stationary engine requires 20 pounds of steam to produce one horse power per hour. Modern engines—meaning good engines of up-to-date design—must furnish one horse power per hour with not more than 14 to 15 pounds. This is often considered good practice by American engineers. In the beginning of these articles I stated* that the continental engineer demands a horse power per hour with about 10 pounds. The turbine, commercially adopted in Europe some ten years earlier than in the United States, would probably have outstripped the reciprocating engine had the latter not been improved. Now as both engine and turbine, here as well as abroad, show a comparatively even steam consumption, it will be some time before the latter takes the lead. As long as steam is used for generating power, the reciprocating engine will never entirely disappear, although we have already sufficient proof that the engine may disappear as the large units of the central power plant. Therefore let us briefly consider the relation of the turbine to the engine and their steam consumptions, obtained in recent practice in the United States. It will be noticed that I have compared power plants of the largest sizes; therefore the same plan will be adopted with respect to prime movers.

The Corliss-valve engine, used almost exclusively in America, as built by Allis Chalmers Company, has reached a maximum size to date of 8,000 horse power. Nine engines of this type and capacity have been installed in the new plant of the Interborough Rapid Transit Company of New York. At this company's (Manhattan) Elevated

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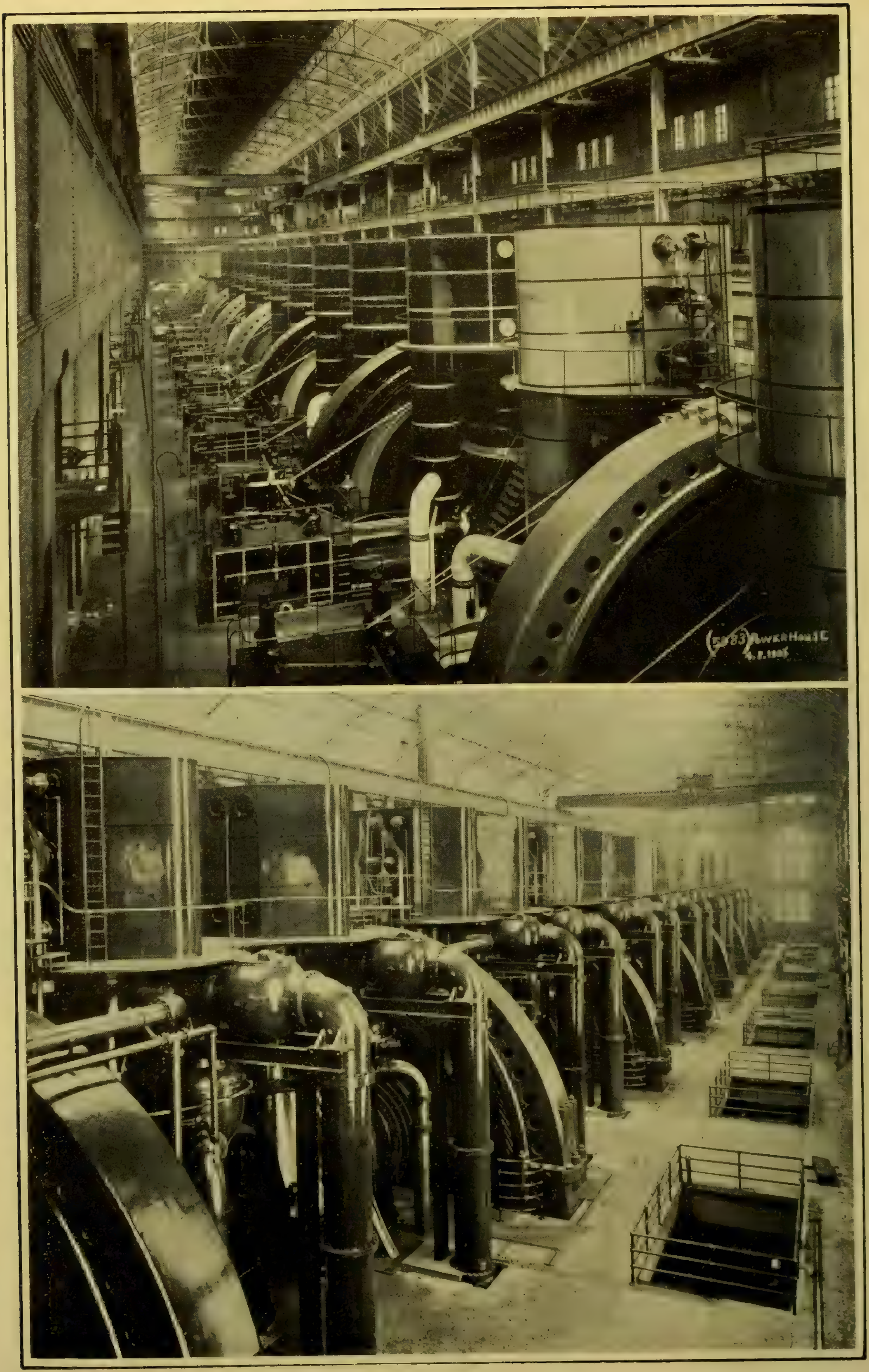
* The Engineering Magazine, August, 1905, page 690.



FIGS. 55 AND 56. PRIME MOVERS IN THE PLANT OF THE INTERBOROUGH COMPANY, NEW YORK.

The upper picture shows the high-pressure cylinder side, and the lower one the condenser side of the engines in the new Subway power station.

Road plant, eight similar units have been installed. See Figures 55 and 56. The latter are plain Corliss-valve engines, while on the former only the low-pressure cylinders have Corliss valves, and the high-pressure cylinders are provided with double-seated poppet valves. As these two engines vary in their dimensions, the following table is submitted:—

	Rapid Transit Co.	Manhattan.
Diameter of high pressure cylinders, inches..	42	44
Diameter of low pressure cylinders, inches..	86	88
Stroke, inches	60	60
Speed, revolutions per min..................	75	75
Steam pressure at throttle, pounds..........	175	150

The guarantee of superheated-steam consumption for the former is 12.25, while that for the Manhattan is 13 pounds per indicated horse power per hour, operating at 7,500 horse power, for which the engines were specified. The actual steam consumption in practice of the former as well as the latter, which have been in operation for several years, is not generally known.

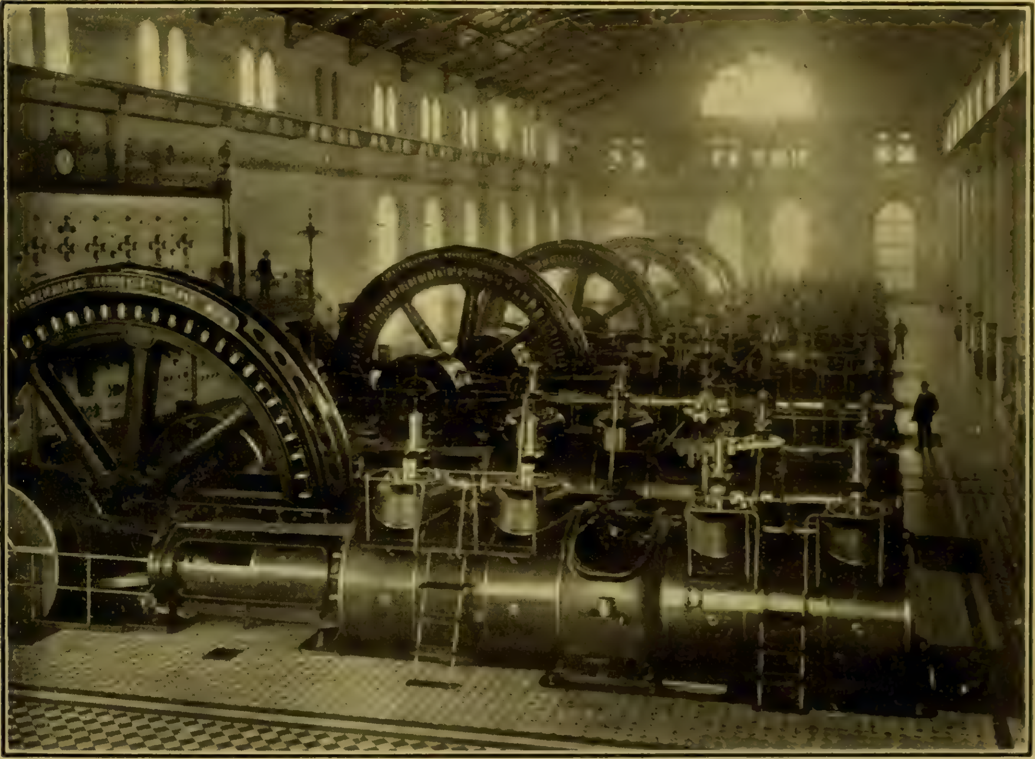


FIG. 57. INTERIOR OF THE MUNICIPAL PLANT AT VIENNA.

3,400-horse-power Sulzer engines built by the Erste Brünner Maschinenfabrik-Gesellschaft.

The 3,400-horse-power Sulzer engine as built by the "Erste Brünner Maschinenfabrik-Gesellschaft" for the twin municipal Vienna plants (as shown in Figure 57), was sold under a guarantee of 10.0

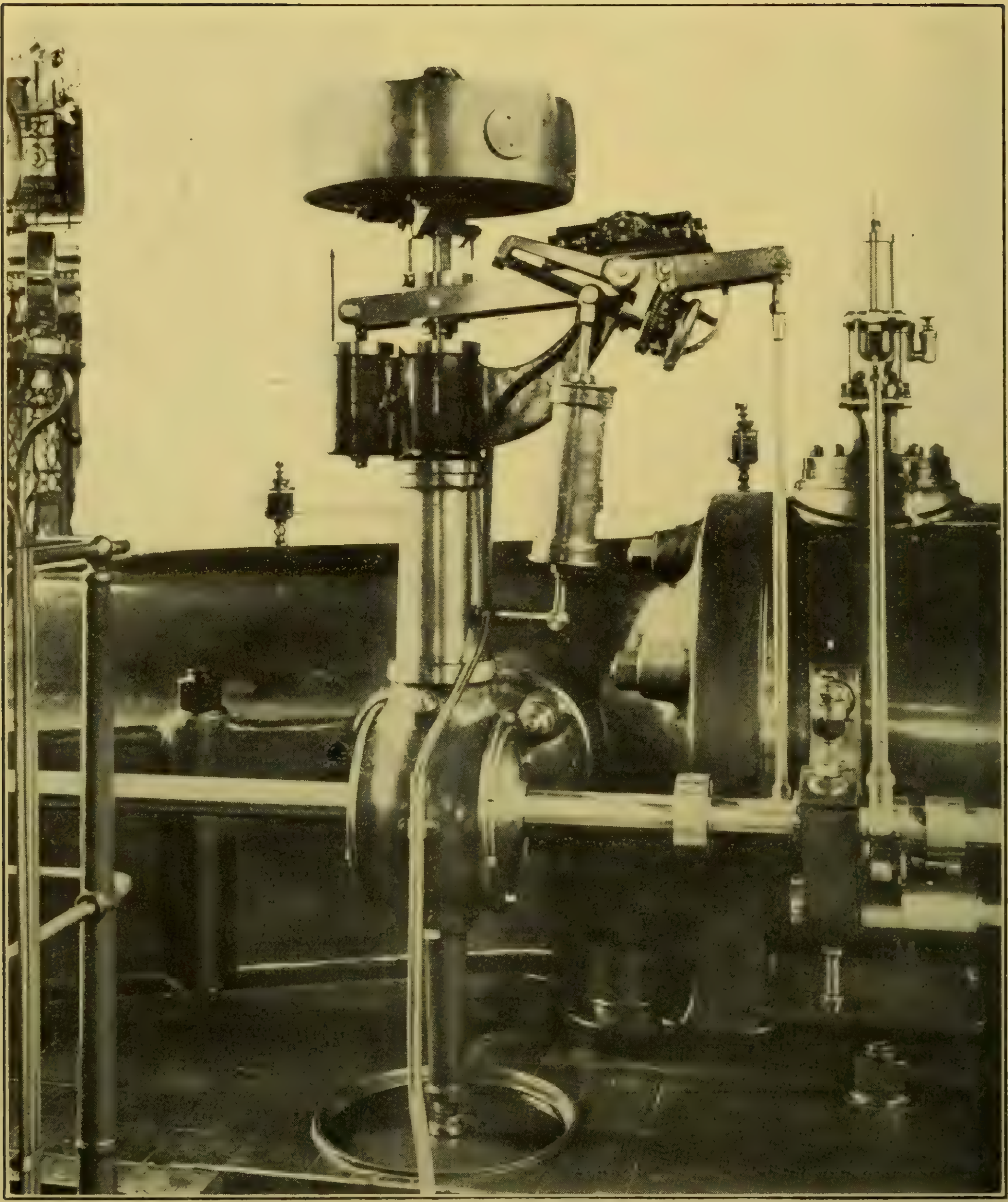


FIG. 58. ELECTRICALLY OPERATED GOVERNOR.

pounds, while the actual running test shows 9.31 pounds per indicated horse power per hour. This engine is a horizontal four-cylinder triple-expansion type with two low-pressure cylinders. The diameters are 31.5 inches, 46 inches, and two 68 inches, and the stroke 59 inches. This engine operates at 90 revolutions and 175-pounds pressure and 570 degrees F. temperature in the valve chamber of the cylinder. Each cylinder has four four-seated poppet valves operated from the main shaft by means of beveled gears, and regulated by a delicate governor limiting the variation of speed to 4 per cent. The cylinders are placed in two rows and the cranks 180 degrees apart. The condenser pump, located below in the basement, is operated from the main crank pin.

The 3,000-horse-power Sulzer engine at the Luisen Strasse station in Berlin operates also under regular conditions with a steam consumption of 9.4 pounds per indicated horse power per hour. The advantages of superheated steam may be clearly shown in this test, which is reported in *Zeitschrift des Vereines Deutscher Ingenieure*. This engine is of the vertical triple-expansion condensing type, with four cylinders arranged in two tiers, the high and intermediate being on top. The cylinder diameters are 34 inches, 49⅜ inches, 61 inches and 61 inches, giving a ratio of 1 :2.1 :6.4, the common stroke being 51 inches, and the revolutions 83 per minute. With a pressure of 210 pounds and a temperature of 590 degrees F. in the poppet-valve, the steam consumption was 9.41 pounds, while with a more moderate temperature, 518 degrees F., the consumption was 9.49 pounds per indicated horse power per hour. With saturated steam, at 360 degrees F. in the valve chamber, the consumption was 10.1 pounds per indicated horse power per hour.

The cylinder ratio of the 5,000-horse-power Sulzer vertical engine at the Metropolitan Electrical Supply Company in London is 1 :4. The

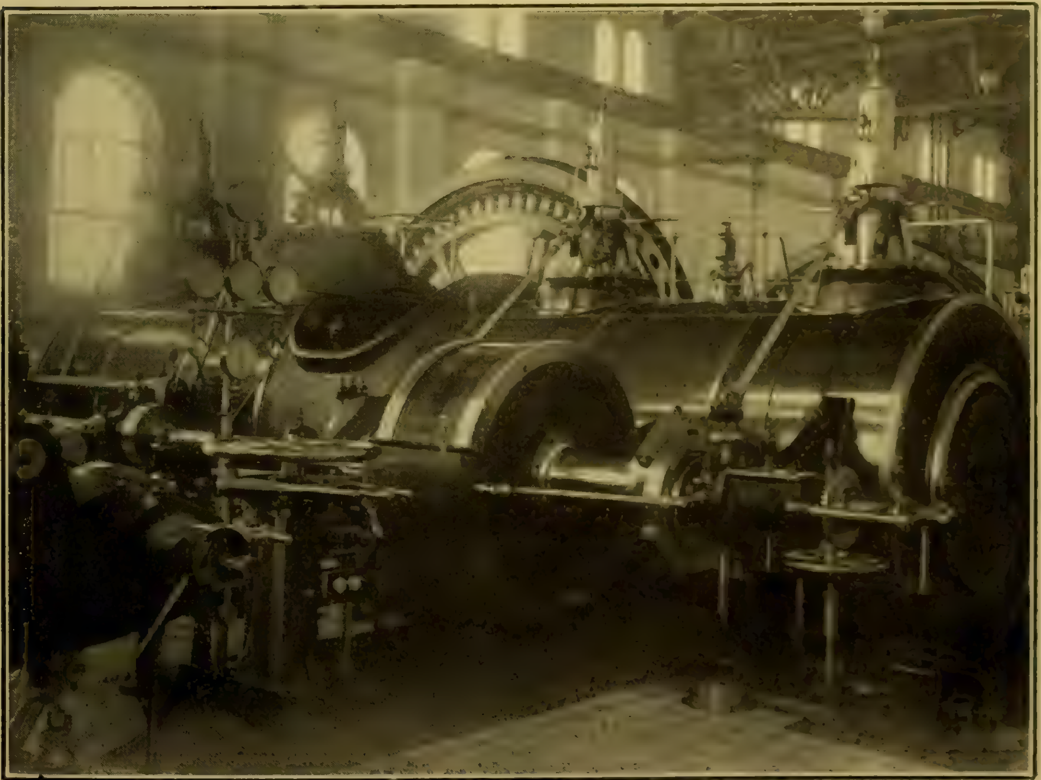


FIG. 59. REGULATING MECHANISM OF A SULZER ENGINE, AS BUILT BY THE ERSTE BRÜNNER MASCHINENFABRIK-GESELLSCHAFT.

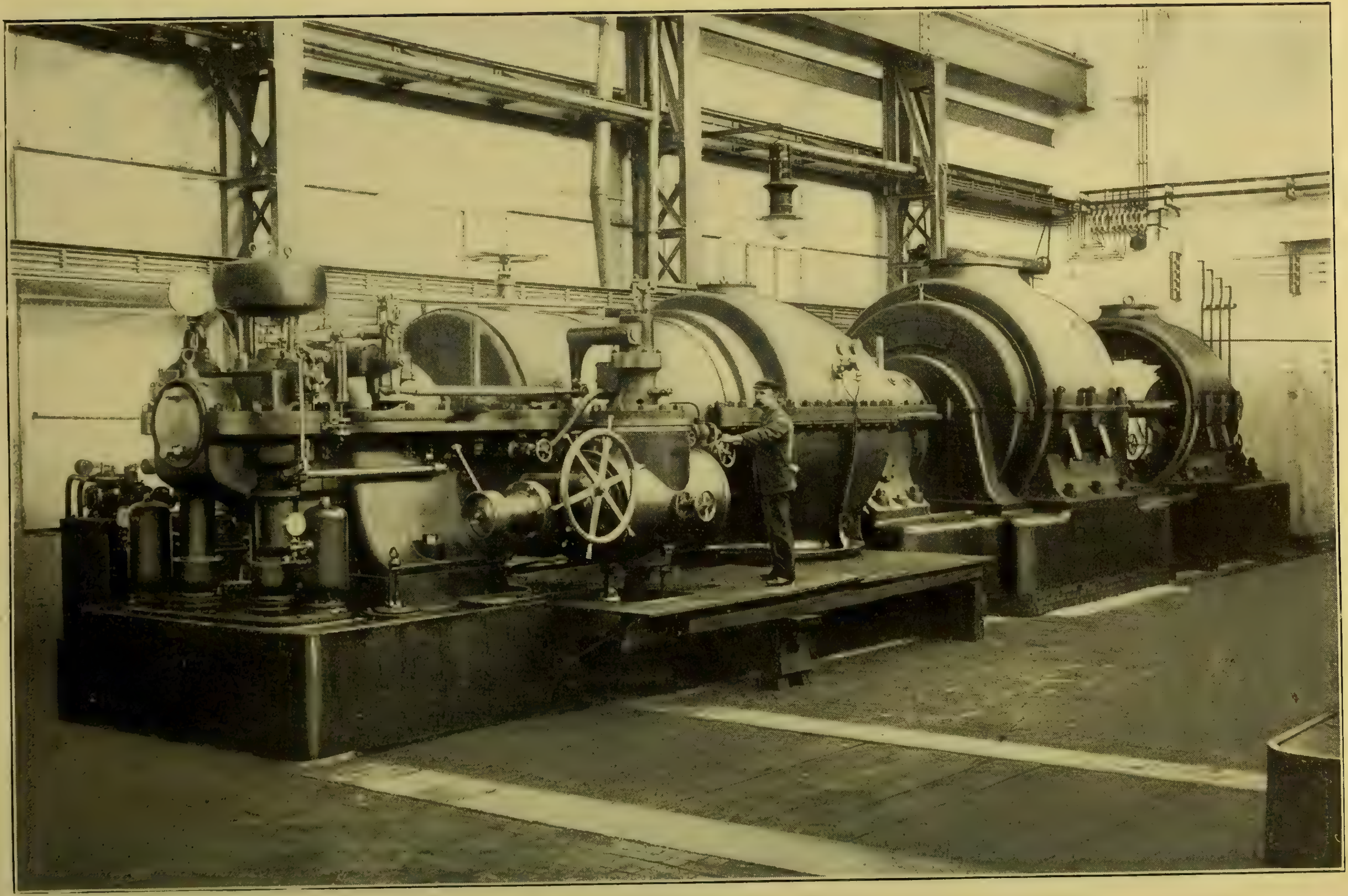


FIG. 60. BROWN-BOVERI-PARSONS 10,000-HORSE-POWER STEAM TURBINE AT THE ESSEN ELECTRIC STATION, GERMANY. Two of these turbines exhaust into one central surface condenser. We are indebted to *Power* for the use of this photograph.

two low-pressure cylinders are placed one on each side of the one high-pressure cylinder, the relative diameters being 71 inches and 50¼ inches, while the common stroke is 51 inches. The engine runs at 75 revolutions. The steam consumption, as reported in the *Zeitschrift des Vereines Deutscher Ingenieure,* for non-condensing is 22 pounds and condensing 13.7 per indicated horse power per hour. It will be noticed that although this engine is of materially greater capacity, the steam consumption, contrary to what might be expected, is increased. I have pointed out at the beginning of this paper that economy of a plant is not only due to the manufacturer, but a great part is due to the power-plant designer and to the management.

Throwing an engine-generator into parallel with units already in operation is usually done in the United States by giving the engine operator, visible or other signals from the switchboard, the switchboard operator waiting till the engine has been brought up to synchronous speed, when the switch is thrown in. The continent of Europe has adopted another practice, which has been in successful operation for many years. Upon the levers of the governor is mounted a small electric motor (see Figure 58) operated from the switchboard after the engine has reached a certain speed. Thus the switchboard operator, usually a more skilled man, has in charge the entire synchronizing of the generator. A horizontal electrically operated governor as well as the fine thorough construction of the regulating mechanism of a typical continental engine are well illustrated in Figure 59.

IX. STEAM TURBINES.*

The steam turbine, although a comparatively recent competitor in the power-plant equipment, shows steam consumption as good as, if not better, than the best reciprocating engine. The most favorable showing of all turbines running to-day is made by the Swiss or German Parsons type, although there are other makes and types pushing them closely. This may be due mainly to one of the greatest pioneers, the Brown-Boveri Company, who realizing at an early date the field of the turbine, pushed it with all possible zeal—with what success is shown in Figure 60, representing a 10,000-horse-power turbine, the largest ever built. I can however state that this company has under course of construction one of 12,000-horse-power capacity. There is no reason to believe that the limit has yet been reached, but on the

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* Franz Koester, *Engineering Record*, Jan. 7, 1905. *Electrical World and Engineer* Feb. 18, 1905. *Western Electrician*, April 8, 1905. *Electrical World and Engineer*, June 3, 1905.

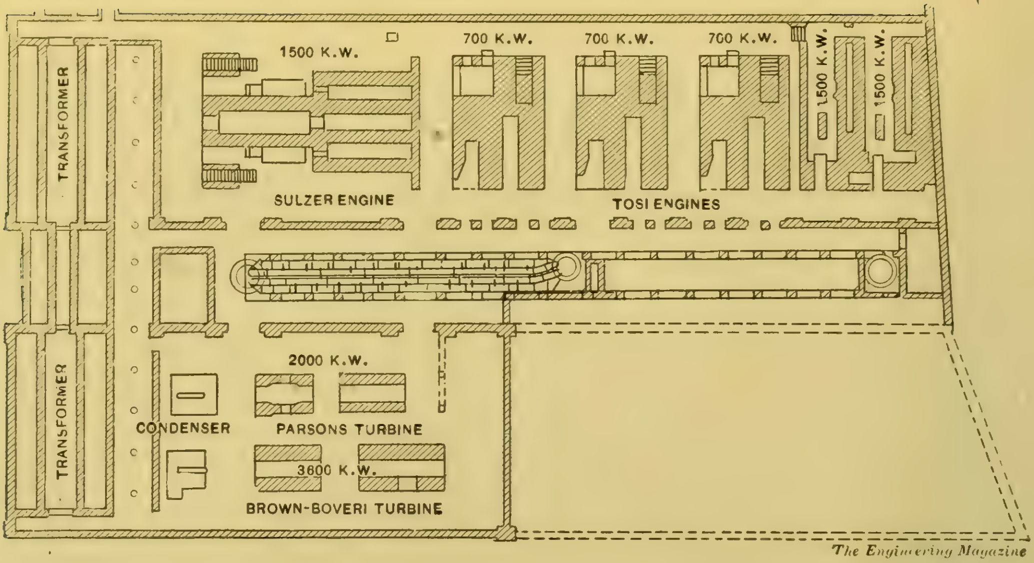

FIG. 61. PORTA VOLTA PLANT AT MILAN.

The upper portion of the plan shows the room containing reciprocating engines of 3,950 kw. output. The turbines in the lower left corner have an output of 5,600 kw.

contrary every reason to expect turbines of even greater size soon to be constructed. The advantages of large-size prime movers for central stations are much increased by the adoption of the steam turbine instead of reciprocating engines, and may be summed up as follows: As the latter has many more moving parts than the former, interruption of service is much more liable to occur on account of breakdowns. The turbine has also proven its superiority by running continuously under normal power plant conditions for some 5,000 to 6,000 hours without any sign of wear, which feat can never be duplicated even by the best built reciprocating engine.

It must be borne in mind that in having only large-size units, during the fluctuation of load, especially noticeable in city traction, some of them are forced to operate under fractional load and, therefore, uneconomical conditions, which may be avoided by the installation of units of intermediate capacity.

The space required by a turbine itself is well-known to be less than that required for a reciprocating engine of the same capacity, but the space occupied in the power plant depends entirely upon the layout where the desire and ability of the designer play a great role. Cases have already occurred where the space occupied for a turbine plant is greater than that required for an engine plant of the same size. It is without question possible to effect a great saving in floor space by the adoption of the steam turbine, an example of which is given in Figure 61, representing the power plant Porta Volta at Milan, the upper half having a capacity 3,950 kilowatts of different types of

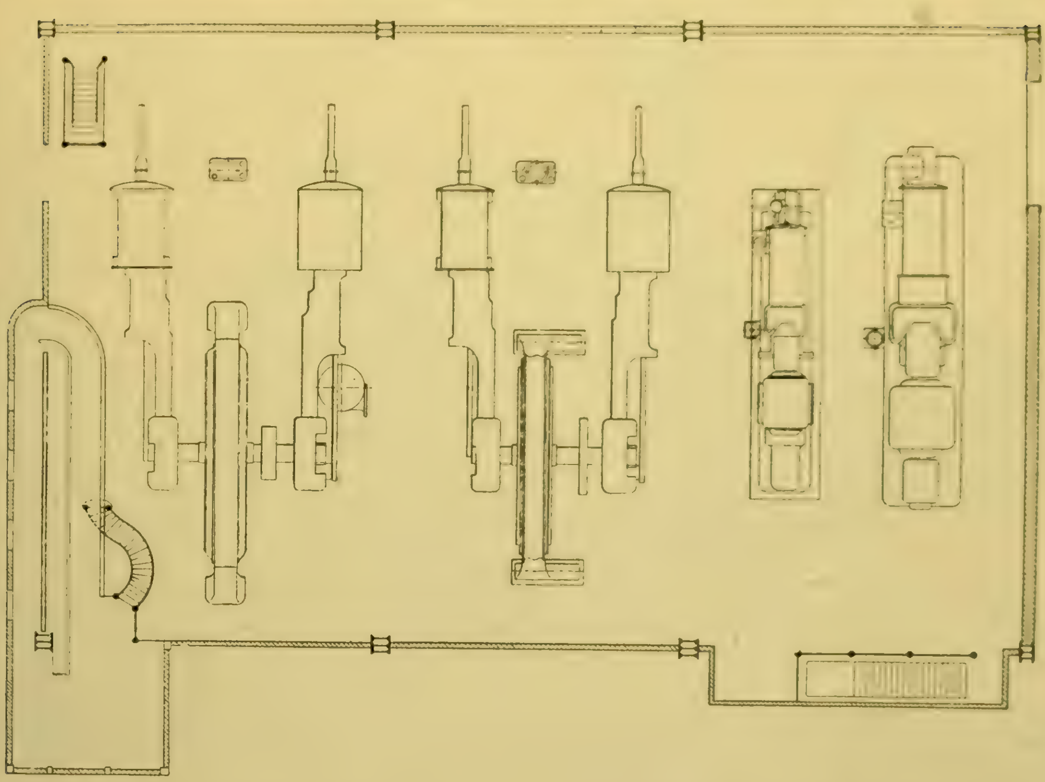

FIG. 62. PUTEAUX PLANT OF THE WEST PARIS ELECTRIC COMPANY, PARIS, FRANCE.

engines, while the lower left hand corner has installed 5,600 kilowatts of Parsons turbines. Although the latter represents an increase of 1,600 kilowatts capacity, it occupies about one-third as much space as the engine room (upper part). Another very interesting case is shown in Figure 62, representing a plan of the Puteaux plant owned by the Electro-Mécanique Company of Paris. Two turbo-generators, one of 1,100-kilowatts, the other of 1,800-kilowatts capacity, occupy the same space previously reserved for one 800-kilowatt horizontal compound engine.

The 10,000-horse-power turbo-tandem, alternating-direct current generator, as seen in Figure 60, has a total weight of 190 long tons, the turbine itself weighing 107 tons. The two generators, one 5,000-kilowatt, three-phase, 50-cycle, 5,000-volt alternating, and one 1,500-kilowatt, 600-volt direct-current, are connected to the turbine by means of isolated flexible couplings, encased in common bearings between the turbine and the generators. The entire length of the set is 65.6 feet, while the width over all is 8.5 feet, and the maximum height from the floor level also 8.5 feet. As will be noticed, all levers and hand wheels are operated from the main floor, which of course would facilitate the operation more than if done from a raised platform. Some other manufacturers of this same type of turbine

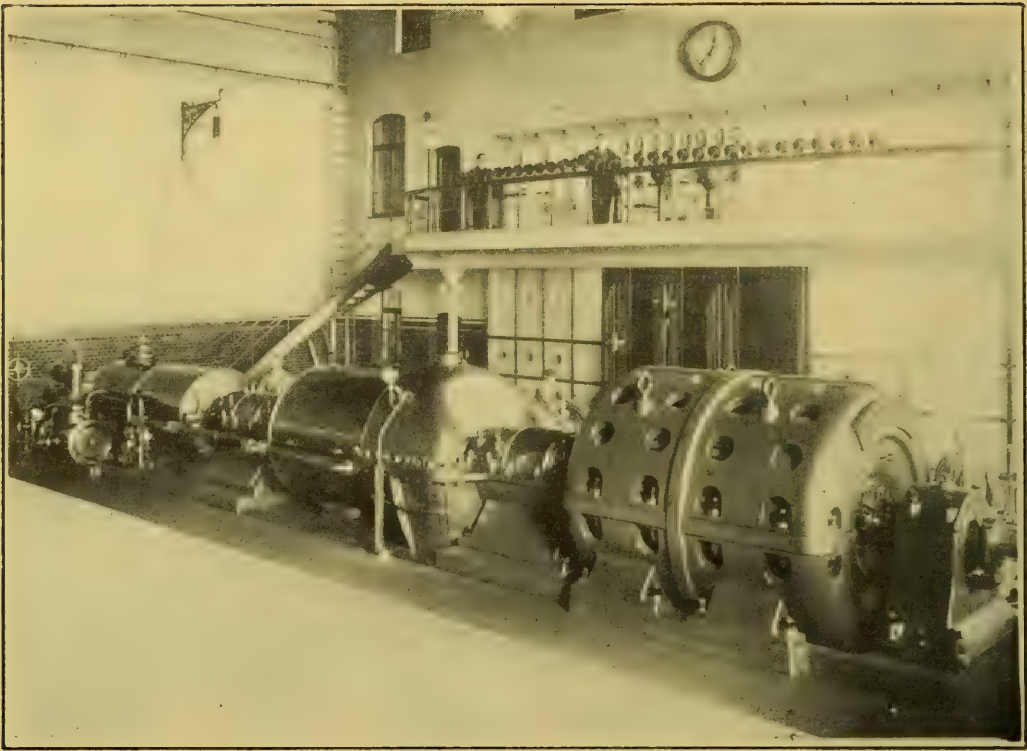

FIG. 63. LIGHTING AND STREET RAILWAY PLANT AT FRANKFORT-ON-THE-MAIN, GERMANY.

4,000-5,000 horse-power Brown-Boveri-Parsons turbo-alternator.

seem to prefer a gallery around the turbine, units even as small as 1,000-kilowatts being provided with galleries at the top of the turbine chamber. One of the principal advantages of the steam turbine over the reciprocating engine, its smallness, is apparently lost in this design. I would like to call attention to the fact that the art of design and construction of a turbine is to obtain the greatest power out of the smallest or seemingly smallest size of turbine. This of course applies also to any other type of engine, and success in accomplishing this result will not only reduce the cost but has numerous other advantages.

Although the turbine does not require a larger condenser than the reciprocating engine, it is true that the condenser outfit of the former occupies generally a larger area, usually in the basement. This is due to the adoption of the surface condenser, which gives a more economical operation, as it allows the condensed steam to be returned directly to the boiler, which in the case of an engine would be impossible on account of the presence of oil in the exhaust. Therefore the surface condenser of a turbine plant may effect a handsome saving, as already shown in the chapter on superheaters.* There will be no special benefit derived from supplying the turbine (or engine) with a jet condenser unless the water is required for some other purpose. As in many cases, with the horizontal turbine, the condenser is located directly beneath the turbine in the basement, it would be good practice to install the pumps beneath the condenser, or directly at the side, in such a way that the condensed steam would flow by gravity to the hot-well pumps.

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* The Engineering Magazine, September, 1905, page 833.

Modern common practice (Continental) in regard to the condition of steam used in turbines as well as engines is 175 to 225 pounds at a temperature from 550 degrees to 750 degrees F. The steam consumption, as has already been stated, is remarkably low there. The 4,500-horse-power Brown-Boveri-Parsons turbo-generator installed in a plant at Frankfort-on-the-Main has a steam consumption of 9.02 pounds per indicated horse power per hour, which is under ordinary operating conditions, but does not include the power required for condensing purposes, this being drawn directly from the bus bars. The above mentioned 10,000-horse-power turbine has

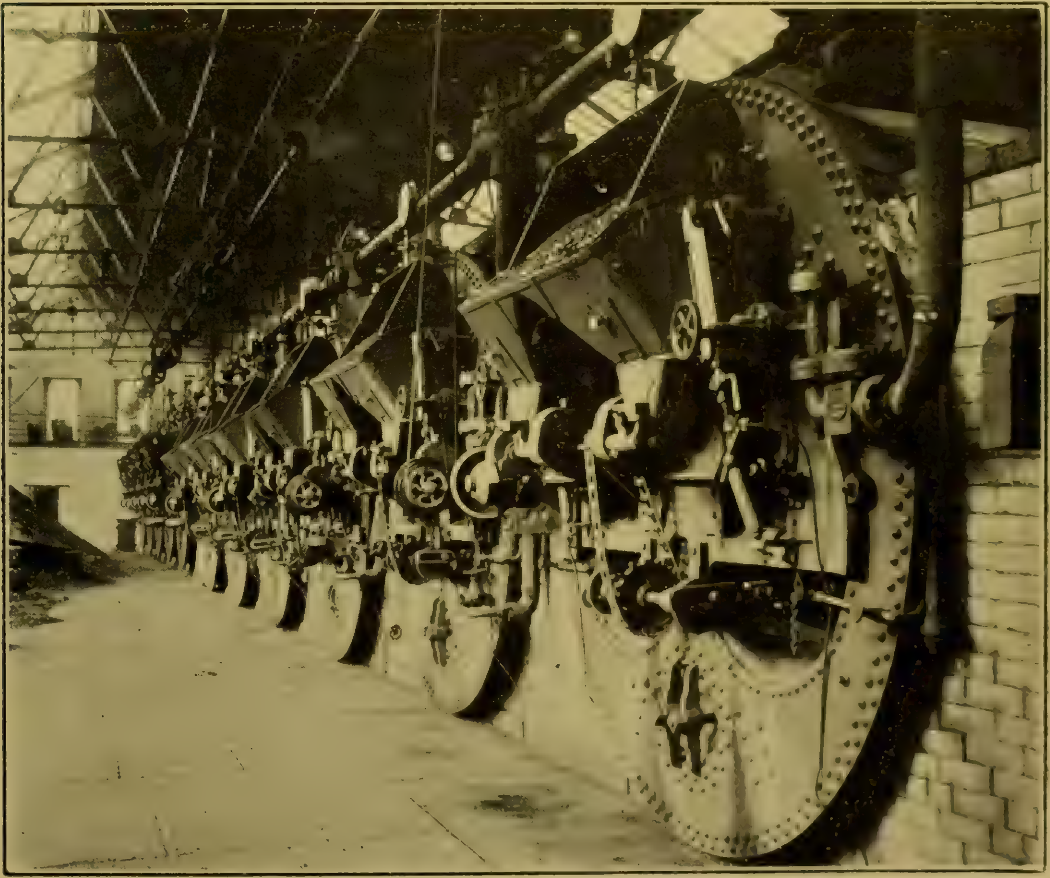

FIG. 64. PROCTOR'S PATENT MECHANICAL STOKER AND MOVING FIRE BARS.
As applied to the boilers at the Corporation Electricity Works, Huddersfield, England, by James Proctor, Ltd., of Burnley.

a guaranteed steam consumption of about 9 pounds per indicated horse power per hour, to which must be added 1½ per cent for motor driven auxiliaries. Two of these turbines exhaust into one central surface condenser. The guarantee for the 5,000-kilowatt turbines in the St. Denis plant of Paris is 9.4 pounds per indicated horse power per hour, in which case the turbines will have to operate under the following conditions. The turbines will run at a speed of 750 revolutions with a pressure of 175 pounds and a temperature of 630 degrees F., while the vacuum must not be less than 27 inches. The 1,500-kilowatt turbine, with the exciter coupled directly onto the main shaft at the Sheffield electricity works, England, runs with a steam pressure of 190 pounds, and a temperature of 475 degrees F. at the throttle. the most favorable steam consumption, as recorded by S. E. Fedden* being 18.4 pounds per kilowatt hour. This test is made under full load. The guarantee of the 5,500-kilowatt British Westinghouse turbines in the Chelsea plant, London, was 15.6 pounds, with a vacuum of 26 inches, while with a vacuum of 27 inches it was 13.2

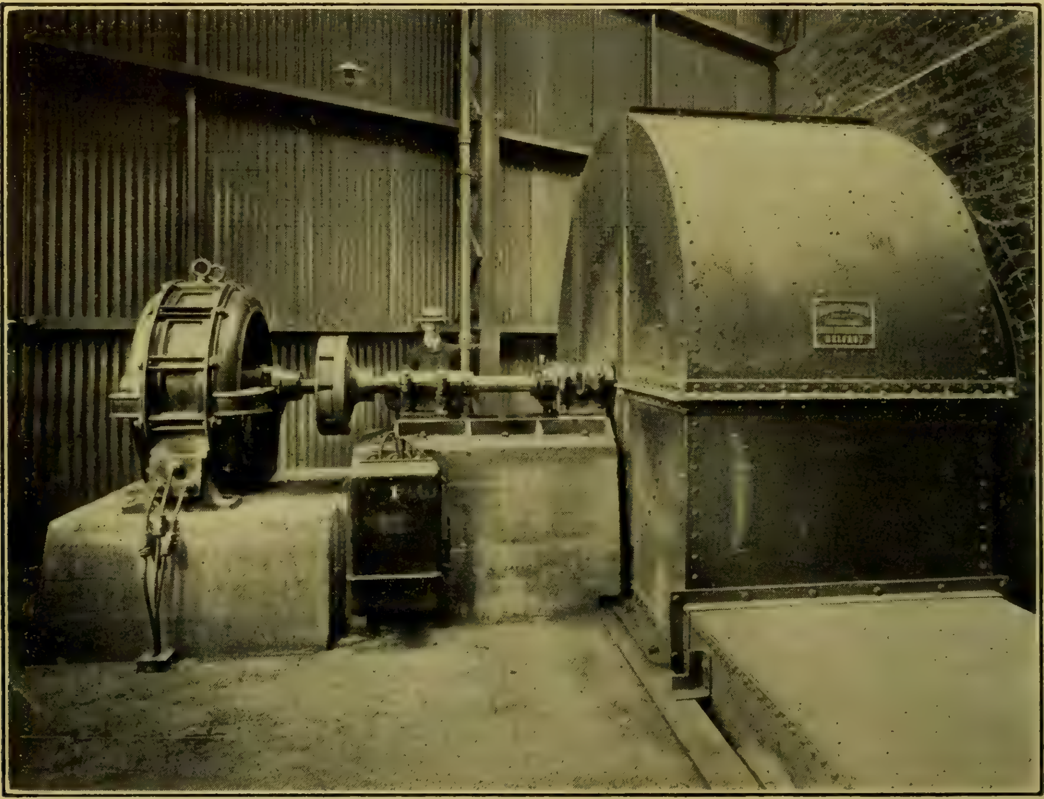

FIG. 65. SIROCCO CENTRIFUGAL CASED FAN, DIRECT COUPLED TO 100-HORSE-POWER ELECTRIC MOTOR.

Three sets supplied to the Carville Power Station of the Newcastle-on-Tyne Corporation by Davidson & Co., Ltd., Sirocco Engineering Works, Belfast.

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* *Engineering*, March 10, 1905.

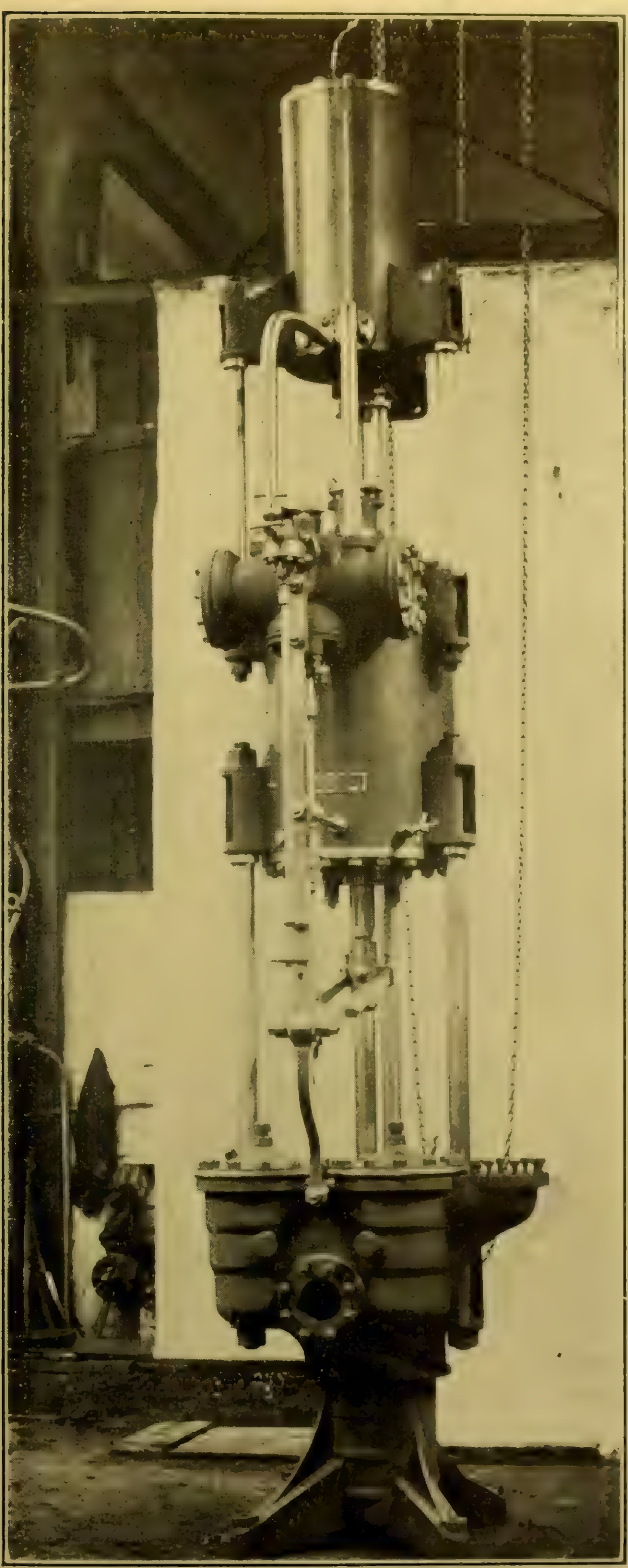


FIG. 66. TANDEM COMPOUND FEED PUMP.

G. & J. Weir, Cathcart, Glasgow.

pounds per indicated horse power per hour. These turbines make 1,000 revolutions with a steam pressure at the throttle of 165 pounds, superheated up to 465 degress F. I can state that steam consumptions considerably lower than 9 pounds per indicated horse power per hour have been obtained, these under purely test conditions, however, which do not count for power-plant operation.

In addition to the advantages already mentioned in connection with the steam turbine must be added the increased ease of governing which is due to the rotary motion, which makes it therefore especially well adapted for operating in multiple with other units. A by-pass valve allows steam to enter directly into the intermediate or lower-pressure chamber, thereby taking care of a sudden overload more quickly than would be possible by starting up a new engine; this is also of service in case of failure of the condenser. By doing this, of course, the steam consumption is increased. To all of the advantages already suggested must be added the cheapness of the turbo-generator unit as compared to the engine-generator set; a 6,000-kilowatt unit of the latter type may cost about twice as much as that of the former.

It may be of interest to give the following data in connection with turbines and modern reciprocating engines. The total weight of a 5-stage 5,000-kilowatt Curtis turbo-generator is about 250 long tons, and it is about 30 feet high (above floor level). The 6,000-kilowatt Brown-Boveri-Parsons, turbine alone weighs about 80 long tons and costs about 45 francs per kilowatt, while the generator of this set weighs 55 tons and costs about 25 francs per kilowatt. The rotating parts only of an 8,000-horse-power Allis-Chalmers engine together with a revolving field of a 5,500-kilowatt Westinghouse alternator weighs 206 long tons. The 3,400-horse-power Sulzer condensing engine at the Vienna plants weighs (without generator) 245 long tons and costs 250,000 kronen.

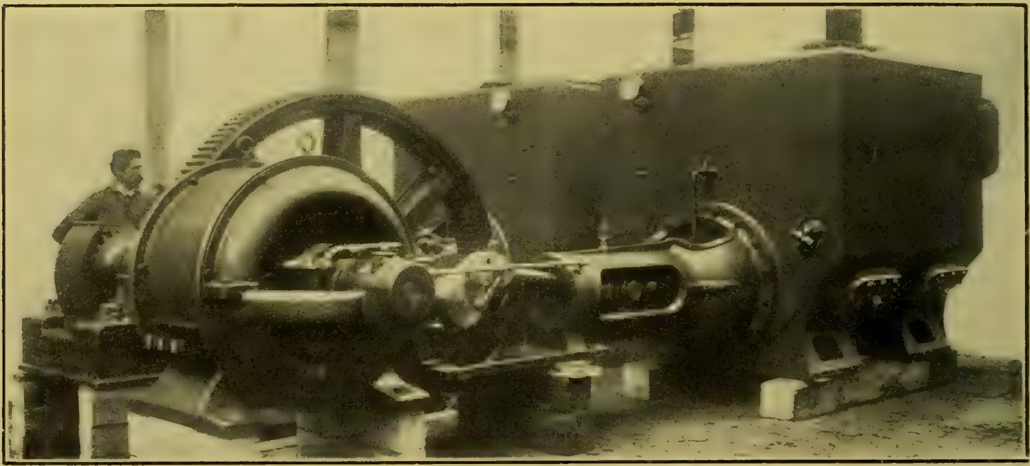
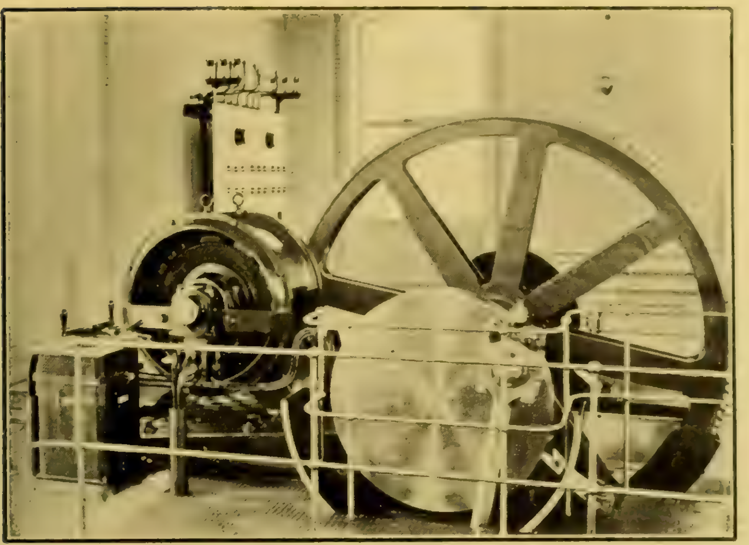


FIG. 67. MOTOR-DRIVEN CONDENSER FOR A 5,000-HORSE-POWER BROWN-BOVERI-PARSONS TURBINE.

X. CONDENSERS AND AUXILIARIES.

A condenser is adopted to create a vacuum as high as possible, which in turn assures a greater efficiency of the engine or turbine, this being generally done by bringing the exhaust steam into close contact with cooling water. The water necessary for this purpose for each particular case depends entirely upon the temperature of the exhaust steam; commonly 30 pounds of water are required per pound of exhaust steam to be condensed. As not all waters can be used with all types of condensers, the latter must be chosen with special regard to the particular grade of cooling water supplied. The con-



densation may be accomplished either by injecting the water directly into the exhaust steam or by conducting the steam over surfaces cooled by circulating water; hence the names jet and surface condensers. These condensers have been designed and constructed in many different forms, most of which are not commonly found in power stations and are therefore without the scope of this article. The jet condensers are classified as the "wet" and "dry" condensers, the words wet and dry, however, by no means being used in their true sense and simply to classify the following types. In the case of the former, the air pump extracts the condensed steam and injected water together with the air, these condensers being often operated directly from the main unit by means of a rod; as at Vienna, where the condenser is connected to a Sulzer engine. In the case of a dry jet condenser, the air pump extracts the air and uncondensed steam only, while the condensed steam and injected water are conveyed off automatically. This type of condenser is also known as the "barometric" or "fall pipe" condenser; see Figure 56, where an Alberger condenser is connected to an Allis-Chalmers engine. A fair degree of vacuum may also be obtained by connect-

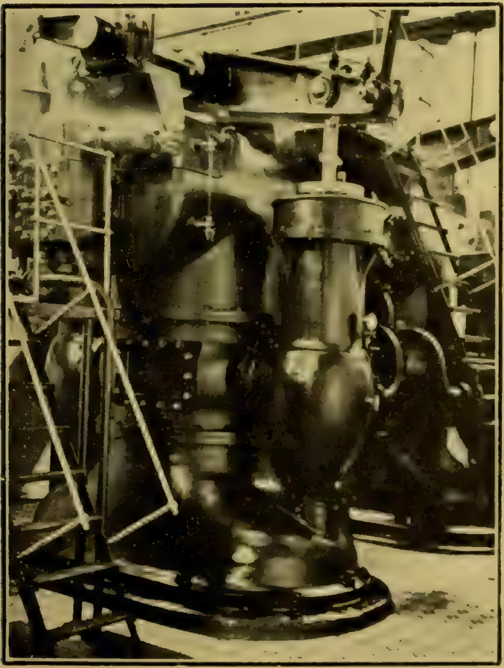


FIG. 68. MOTOR-DRIVEN PLUNGER PUMP FOR COOLING WATER AT THE TWIN POWER PLANT IN VIENNA.

The upper figure on this page shows the driving machinery; the lower shows the pump, which is placed on the floor below that carrying the motor.

ing the air suction direct to the tail pipe and omitting the air pump. The water may flow either by gravity to a tank, which must be not less than 25 feet below the injection opening of the condenser, as the vacuum will readily lift the water to that height, or where such an arrangement cannot be obtained the water must be injected by means of a pump, in which case the vacuum in the condenser will assist the pump to perform its duty. The barometric condenser may also be successfully employed as a central condenser where more than one engine exhaust to one condenser, as in the new Kingsbridge (New York) station where the exhaust pipes from four 4,500-horse-power engines are connected to a single 54-inch main leading to a single condenser capable of handling the exhaust of 25,000 horse power, and as there are four such condensers for sixteen engines it will be seen that in case of an emergency the plant may be operated on three condensers. The surface condensers may be classified as "closed" or "open" type. The former generally consists of a number of tubes in a closed chamber through which the water passes, a counter current being usually adopted. In the open type, the exhaust steam may pass through a series of tubes surrounded by cooling water in trays directly exposed to the atmosphere. This apparatus is not as favorably considered as the closed type, which is the best type in existence for use with steam turbines on account of the oil-free exhaust.

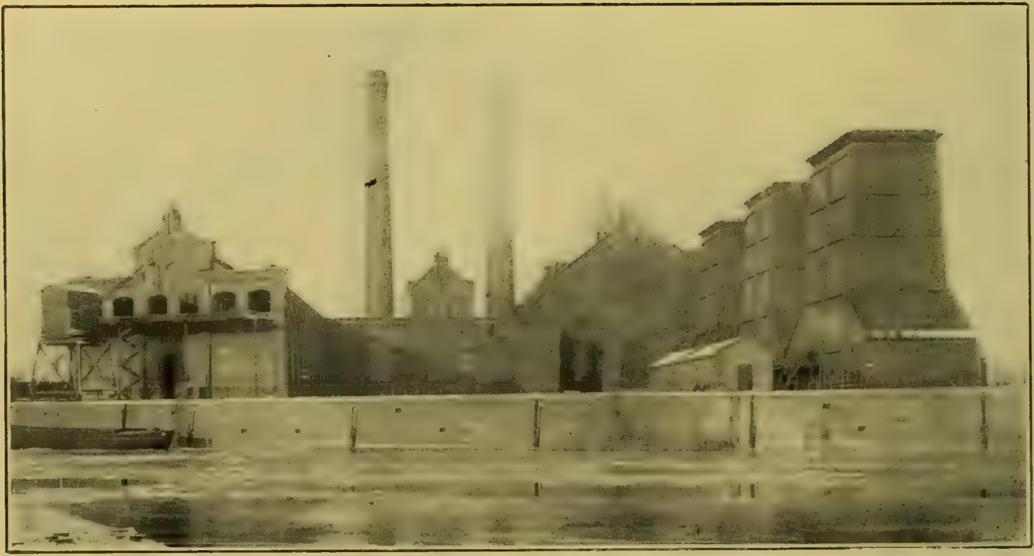


FIG. 69. COOLING TOWERS AT THE "BILLE" PLANT, HAMBURG.

In order to assure a good vacuum all leaks must be avoided, which result may be facilitated by placing the condenser as close to the engines as possible and by using, as already stated, water sill flanges, which is easily possible in vertical runs. Provision must also be made for free atmospheric exhaust in case of failure of the condenser.

The power required for running the auxiliaries should be not more than 5 per cent. of the total power; good engineering practice however allows only 2 per cent. This consumption has proven possible in many plants on the continent of Europe. These auxiliaries are usually electrically driven, and may be either of the plunger or centrifugal type. As Continental practice has long ago proven the efficiency of this system, and as the British practice is rapidly tending in this direction, I do not doubt but that it will ultimately be universally adopted.

Where the supply of cooling water is limited, cooling towers may be advantageously installed in order to use the water over again. There are two types of coolers—1, when the tower is of sufficient height to create a natural draft assisted by the heated air from the condensers; 2, when the air is circulated by one or more fans, thus considerably reducing the height of the tower and also occupying less space. Both of these types of cooling towers may be built of either wood or steel construction, the latter being usually of cylindrical type. The accompanying illustration, Figure 69, gives a splendid view of a natural-draught cooling tower installed in the power plant Bille, Hamburg. A single combined hot-and-cold-water pump may force the water through the condenser, whence it runs to the hot well, is taken up by the pump, sent to the cooling tower, and again taken up from the cold-water pit to the condenser. Where the distribution troughs of the cooling tower lie below the level of the condenser outlet, it is possible to depend upon gravity to take the hot water to the tower, thus reducing the power required for auxiliaries. The oil carried in the exhaust from reciprocating engines is usually abstracted by means of overflows, but in case any of this water is to be again fed to the boiler great care must be taken to filter out all the oil carefully, as the disastrous effect of the presence of any oil in the boiler is well-known.

HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker and Walter Brown.

In the present article, which is the second of a series containing a very valuable practical study of the use and effects of high-speed tool steel in one of the largest American machine shops, the details of introducing the new steels, both with regard to the men and to the machines, are discussed. The first article, which appeared last month, showed that, in general, the factory manager will find it to his advantage to adapt his existing equipment to the new conditions as far as possible, and work it to the limit until it is worn out, rather than to instal new machines at once. The carbon tools should be replaced by the alloy steels only gradually, each case being considered on its own merits, and in introducing the new tools, it will be found economical to secure the services of an expert.—The Editors.

II. CONTROLLING PRINCIPLES IN MAKING THE INTRODUCTION.

ANY business organization, and particularly that of a big factory, is a delicately balanced mechanism which cannot be rudely disturbed without seriously interfering with its smooth operation. There are doubtless some changes of a sweeping nature that could be made with great advantage in almost every large industrial plant, even at the risk of some confusion and temporary disorganization. It is usually safer, however, to make important changes gradually. The matter of changing the materials used in the manufacturing tools might seem to have little or no bearing upon the factory organization and management outside the one feature of costs. The question is not, however, one of tools and costs only. There is another factor that requires even more careful consideration than either of these, namely, the men who use the tools and through whom the costs will be changed. Tools could be promptly designed for the desired new conditions, machines altered, and costs re-figured with little trouble; but unless the workmen are also considered there is almost certain to be rough water ahead. For this reason mainly it is desirable to make the change cautiously and not too abruptly, always with due and just consideration of the man who uses the tool. There is a second reason for making such a change without unnecessary haste; namely, the need for trying out the various jobs to ascertain just where high speed tools can be used to advantage. For, as pointed out in the previous paper, there are likely to be many cases where it is just as well, and possibly better, to use carbon or self-hardening tools. Really, however, the latter need not be seriously considered, mainly because the socalled self-hardening is only an intermediate step between carbon and high-speed steel, and its promoters are, for the most part, turning their attention to the high-speed product. In order, therefore, to secure satisfactory results it is necessary to make a careful study of the situation as it exists in the particular factory in consideration.

That is a very conservatively or ignorantly managed machine shop wherein no high-speed steel at all is used. On the other hand, the number of shops making use of the new steels to anything like the extent it could profitably and satisfactorily be done, is not large. A small amount of the steel is used in many shops. In most such cases there is little inclination to make a large use of it because the results have been much short of those expected. The failure to obtain satisfactory results under these circumstances is usually due to the very fact that so little is used, in consequence of which there has been no expert development of the subject, the matter being usually left in the hands of men understanding neither the nature nor methods of treatment of the alloy steels. It would be surprising indeed if, under such circumstances, wholly satisfactory results should be obtained. The very first thing that ought to be considered in planning for the extensive use of high-speed tools is intelligent direction and handling. This given, there can be no question as to obtaining results.

Just here it is well to consider a few cautions whose observance will be certain to prevent many failures or half-successes and disappointments.

It is unnecessary to experiment with all, or many, of the fifty or more brands of alloy steel now upon the market to determine which is best, or to try out every job in the factory to find out where it is profitable. While it is true that some of the brands are for general purposes better than others, and that certain ones are probably better adapted to some jobs than to others, on the whole it is not desirable to undertake to test more than one or two at the beginning. It is important only that the brand selected for first introduction be one well-known for its merit. The introduction once made and workmen educated to the proper management and use of the new tools, there will be time enough to carry on careful comparative tests upon the various makes. If reliance be placed upon the regular tool makers, even if under the direction of an expert thoroughly familiar with alloy steels, there will undoubtedly be troubles enough in acquiring the necessary experience and skill to make and handle them properly, without the additional distractions incident to comparative tests. And while also it is true that every job and tool should be related according to the conditions governing in each case, there are nevertheless typical jobs that can be utilized for drawing general conclusions and for determining the adaptability of a new tool to that class of work and machines. When it comes to fixing new rates, of course, certain data must be secured for each job—a matter taken up hereafter.

Second, the use of existing installations without considerable modification will not yield any astonishing results. Unless the machines already in use are adapted to the greatest possible extent to the new conditions, the economies effected will be, on the whole, rather moderate—sufficient in most cases, however, to demonstrate the advantage of using the new tool. This feature will be more fully discussed in a later paper.

Third, it is important to obtain the co-operation and interest of the men who are to use the new tools. Usually they look with suspicion and disfavor upon anything that tends to require greater exertion in earning a day's wages or threatens to diminish the number of men necessary to secure the required output. The use of high-speed tools, from the very nature of the case, presumes more activity on the part of the operator in a given time. He must handle more pieces and do more work, and that at a higher nervous pressure. He is justly entitled, in return for his increased exertion, to a share in the profits. Any attempt of the employer to monopolize the profit will be properly resented by the workmen, with the result that a relatively unsatisfactory showing is made.

The question now presents itself, how to take up the high-speed-tool proposition—what method or system to employ in determining when and where to use it, as well as the collateral questions, not the least important of which is that of the readjusted piece-work price. It would be futile to say dogmatically that one or another method ought or ought not to be employed. Any method will serve if it be not too cumbersome and if it be used intelligently by men having some familiarity with the matter in hand. Obviously it will be desirable to make use of some method harmonizing with the system of management in force in the shop or factory. This holds true of a small shop employing few men and machines as well as of a great factory.

Of the two systems of factory management ordinarily found in practice, the monarchical one-man system and the oligarchical committee system, the latter if applied to the high-speed-steel proposition would have the advantage of creating a greater immediate interest and would necessitate less diplomacy and tact in the dealings with the workmen and foremen affected. It is, however, open to the objection that it is somewhat cumbersome and puts a good many fingers into the pie. If one or more members of the committee have a good working knowledge of alloy-steel properties and behavior, so much the better. If not, it will be almost necessary, in order to make headway and to avoid disappointments, to secure the services of an expert who can give direction and point to work of the committee.

If the whole matter be put into the hands of one man with more or less experience in handling high-speed steel, it is important that he be endowed with tact enough not to procure the distrust of the workmen and the antagonism of the foremen. Lacking in this respect, the difficulties will be greatly increased. For this reason it is desirable to select a man already familiar with the factory system and men, if such a one be available.

Evidently, the point of attack in making an introduction of high-speed tools into the factory or shop will be by way of those jobs that are especially trying to the tools in use, and because of the simplicity of the tools, preferably through turning operations. Where tool holders are in use the expense for tools for this class of jobs is insignificant. There are however certain objections to the use of tool holders, considered more fully hereafter, which arise from the impossibility of attaining the greatest practicable speed or heaviness of feed, so that it is much better to use solid tools. But these also are simple in form, except for jobs having special requirements, and offer fewer difficulties to the tool maker than most other tools.

Suppose for example, the job selected is that of finishing a high-carbon shaft requiring a long cut. Without any change in the speed or feed there will be an immediate advantage apparent in that the new tool will finish many more pieces at a grinding than was previously possible. Usually it will be possible also to speed up the lathe so as to gain largely in cutting time. Unless there should be some unusual conditions there ought to be no difficulty in reaching a speed from 100 to 300 or 400 per cent. faster than with carbon-steel tools, and from 25 to 100 per cent. faster than with the self-hardening.

The determination of the maximum speed will doubtless require close study of the quality of the product, the limitations of the machine, and the life of the tool; and it may therefore require some little time. It is worth while establishing the limit with some degree of definiteness, however, so as to get a criterion for all similar jobs. An approximate standard of speed once determined for each class of jobs, much time will be saved and trouble avoided by using it in all cases to which it is applicable until experience shows modifications to be of advantage.

In fixing upon such a standard certain elements will at once become evident as determinants. First of all will be the nature of the material, whether of high- or low-carbon steel, malleable, or of soft or hard gray iron. Obviously the same speed would be out of the question with all these, even if all other conditions could be made similar. A second factor is the age and design of the machine used, which is assumed to be of the ordinary type of present installation. Unless it is pretty rigid and a little worn it is quite likely to spring under the higher requirement, so that accuracy of work cannot be depended upon if speeded too high. Furthermore the piece itself may give also, and add to the difficulty.

Again, there is the question of additional driving power to take care of the increased speed. In this connection it should be remembered that while the amount of power required to drive a machine at the higher speed is greater than at the lower, the total quantity necessary for doing a piece of work is no greater. Indeed, in most cases the amount is actually less, because of the greater efficiency at the high speed.

Still again, if the piece turns on centers there arises the difficulty of keeping the centers true. A small piece rotating very rapidly may easily burn off the center in a short time. But this is not a serious matter. The lathe center itself can be made of high-speed steel and the whole difficulty obviated.

It is seen that every job, or at any rate every class of jobs, must be studied with reference to a great variety of relations and regarded with respect to its own peculiar limitations. The great variety of conditions makes it very difficult to generalize or to mark distinct classifications of jobs. The usefulness of such a classification in respect to speeds has already been pointed out. It is equally useful in a study of the making and tempering of the tools, as will be shown in a later paper. The following is given as suggestive:

1. Hard steel, large diameter, heavy cut.
2. Hard steel, large diameter, light cut.
3. Hard steel, small diameter, light cut.
4. Soft steel, large diameter, heavy cut.
5. Soft steel, large diameter, light cut.
6. Soft steel, small diameter, light cut.
7. Malleable, small diameter.
8. Malleable, large diameter.
9. Gray iron, large diameter, heavy cut.
10. Gray iron, large diameter, light cut.
11. Gray iron, small diameter, light cut.
12. Gray iron, extra hard.

This classification by no means covers the ground completely, and lacks a good deal of fitting all jobs. The most that can be said of it is that it is reasonably concise and offers a convenient basis of tentative reference for most jobs. In a later paper dealing with practicable feeds and speeds, an attempt will be made to designate approximate standards in connection with this classification, which may serve as a series of convenient starting points in testing and trying out new tools.

In this discussion lathe tools alone have been considered thus far, for reasons already given. Nearly all that has been said will apply with equal force to other kinds as well; and if tools such as drills, reamers, millers, and similar cutters, are bought ready made to specifications, or are made and hardened in the shop by tool makers thoroughly acquainted with the new steels, there is no reason why such should not be used from the beginning.

Of the making of tests there is no end, in a well administered industrial plant. The management that is satisfied with what is. inevitably finds itself distanced by its more energetic and wide awake competitors who stand ready to inquire into everything that has even slight promise of economies to come. The high-speed steels certainly have very much of promise in them, and have indeed thoroughly proved themselves wherever given half a chance. Clearly it is worth while to do a good deal of testing with this new tool material. But there are tests, and tests. The endurance and cutting capacity of a drill, for example, can of course be determined by drilling a plate full enough of holes to convert it into a sieve; and that of a lathe tool by paring down rods and cylinders indefinitely. Doubtless such tests were once valuable. They are however no longer necessary and but rarely desirable. The extraordinary performances of these steels are too well known. If it is desired to learn the life of a tool in comparison with another, it can be done just as well, and much more profitably on a regular job and under the conditions that usually govern in the manufacture of a commercial product.

The try-out or test, whether made by the high-speed-tool expert, the committeeman, the foreman, or the workman, of course has for its end the determination of some fact or number of facts upon which generalizations may be based or which will assist in arriving at the cost of production under the changed conditions. It is therefore essential that the data gathered be accurate and relevant to the end sought, and preserved in form for convenient reference. Without such a record the readjustment of the workman's pay, upon which the whole question of high-speed tools chiefly hinges, is merely guesswork with no rational basis, just as rate fixing under the usual circumstances is in nearly all shops. That is to say, the use of the new tools is, the quality of the work being satisfactory, a question of increased profit or perhaps it were better to say, of reduced cost of production. Since the cost of production is chiefly that involved in the piece-work rate paid to the workman, he not only is the center of attention on the part of the investigator, but very naturally becomes much interested himself.

Now the piece worker is extremely sensitive to changes in his rate, and one of the great problems in factory management is to keep rates so adjusted as to get the most economical production consistent with the required quality of the output. The cost of production however is not altogether determined by the piece-work price. Among the other factors one of the most important is the intelligence of the body of workmen and their attitude toward the employer. In proportion as the operatives are ignorant, unskilled, discontented, and lacking in interest, the cost of production goes up. Without a reasonably satisfied and loyal corps of employees there can be no such thing as continued profitable production, no matter how cheaply work may be turned out for the time being. In the long run, strikes, shutdowns, idle machinery and capital making no turnover, a constantly changing body of workmen—all must be reckoned as a part of the cost of production; and all point to the importance of the human factor in the equipment and running of the factory—a factor all too frequently ignored or treated with scant regard to sound principles of mechanics, which in this case are also sound principles of humanity and justice. That is to say, one of the chief elements in the problem of introducing high-speed tools is to adjust the new rates with immediate profit to the management and justice to the operative.

A fundamental principle in any such readjustment therefore is that the workman is to have an increase in total earnings commensurable with the increased work required of him under the new conditions. Not a temporary increase, to be wiped out at an opportune moment, as most managers know so well how to do; but a permanent increment assured in good faith by merited confidence in the employer. Disregard of this principle is sure to limit the ultimate profit in ways often indirect and intangible but none the less positive and appreciable. The amount of increase obviously will depend upon a number of things, but especially upon the amount of saving effected and the increased exertion; and it ought in every case to be satisfactory to the man, as it usually will be if he is tactfully taken into counsel.

Now as to fixing the rate:—Of course the foreman, or whoever is charged with rate fixing, could probably make a passable guess at a fair price after making a try-out or watching one. There are however so many chances for mistake that the only safe way is to determine a new rate directly from the data gathered and recorded in connection with each particular job. Suppose a concrete example be taken, an actual case.

The following data are available in the pay roll and other regular factory records; season's requirement, 24,000 pieces; average daily output (two lathes), 92 pieces; piece-work rate, $2.125 per hundred; average daily wage, $1.91.

Observation of the job develops, among others, the following with reference to the performance of the self-hardening tool: actual cutting time, 8 minutes; cost of tool per hundred pieces, 3 cents; pieces finished per grinding of tool, 5; average time required per grinding and setting of tool, 5 minutes. A little calculation, as here shown, brings out that the time required for finishing a piece is 13 minutes, and the time allowance for setting up, handling, cleaning machine, and other lost time, 4 minutes:

Average daily output (10 hours or 600 minutes), 92 pieces; whence the average time per piece = 600 ÷ 92, or 6.5 minutes.

But since two machines are operated, the actual time required per piece = 2 x 6.5, or 13 minutes.

Since the time required for grinding and setting the tool for 5 pieces is 5 minutes, the time per piece = 1 minute.

The actual cutting time (stop-watch observation) = 8 minutes.

Then the time allowance = 13 — (8 + 1 =) 9, or 4 minutes.

Taking now the data developed by observation upon the performance of the high-speed tool, we have the following result:

Actual cutting time (stop-watch observation), ...	4.5 minutes.
*Time for grinding and setting tool, per piece, ...	.2 minutes.
Time allowance (handling, etc.), ...	4.0 minutes.
Total time for finishing, per piece, ...	8.7 minutes.

But as two lathes are operated, the finishing time per piece is only half as great, or 4.35 minutes.

Whence the daily output is (600 ÷ 4.35 =) 135 pieces, or more than 50 per cent. greater than before.

It will doubtless be asked by some, why go to all this trouble to find out how many pieces are produced a day? Why not let the foreman work the job for a short time? or why not count the pieces at the end of the day and be done with it? The answer is that these methods

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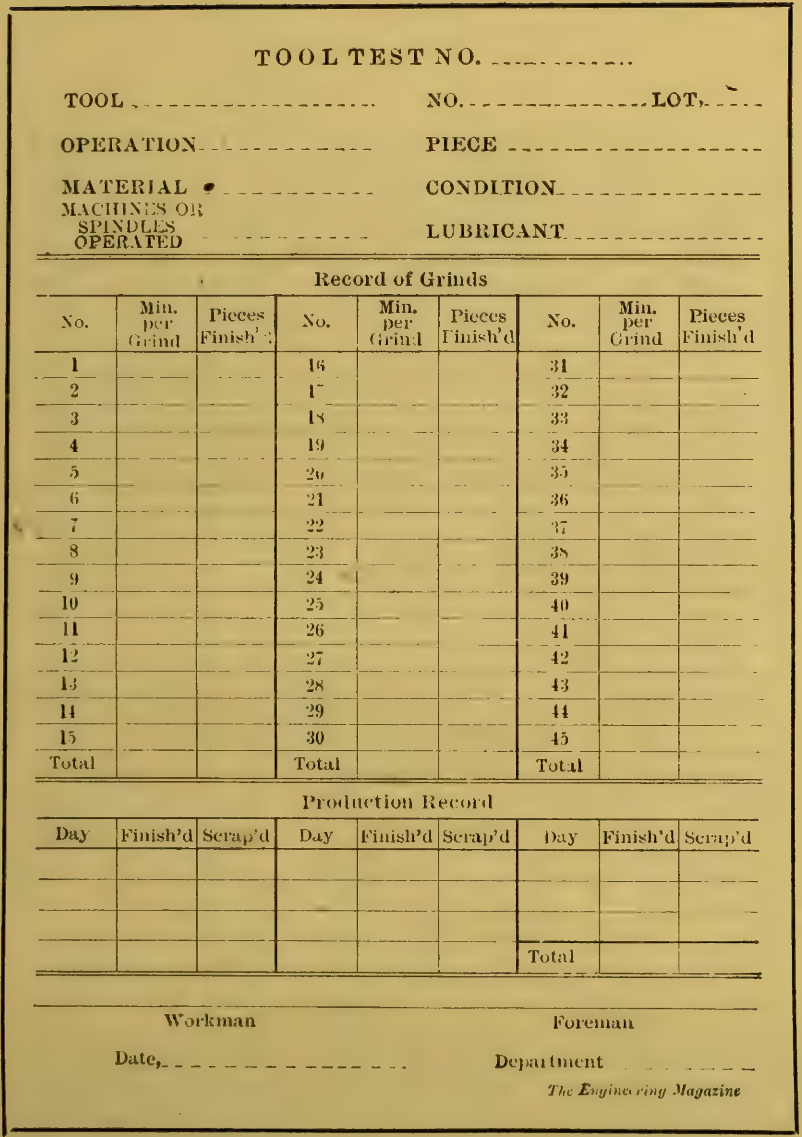
* It is worthy of note that 22 per cent. of the time saved is the result of fewer grindings and settings of the tool. Of course the proportion would be much less in any job where the material to be machined was of the usual softness.



TOOL TEST NO.

TOOL NO. LOT,

OPERATION PIECE

MATERIAL CONDITION

MACHINES OR SPINDLES OPERATED LUBRICANT

Record of Grinds

No.	Min. per Grind	Pieces Finish'd	No.	Min. per Grind	Pieces Finish'd	No.	Min. per Grind	Pieces Finish'd
1			16			31		
2			17			32		
3			18			33		
4			19			34		
5			20			35		
6			21			36		
7			22			37		
8			23			38		
9			24			39		
10			25			40		
11			26			41		
12			27			42		
13			28			43		
14			29			44		
15			30			45		
Total			Total			Total		

Production Record

Day	Finish'd	Scrap'd	Day	Finish'd	Scrap'd	Day	Finish'd	Scrap'd
						Total		

Workman Foreman

Date, Department

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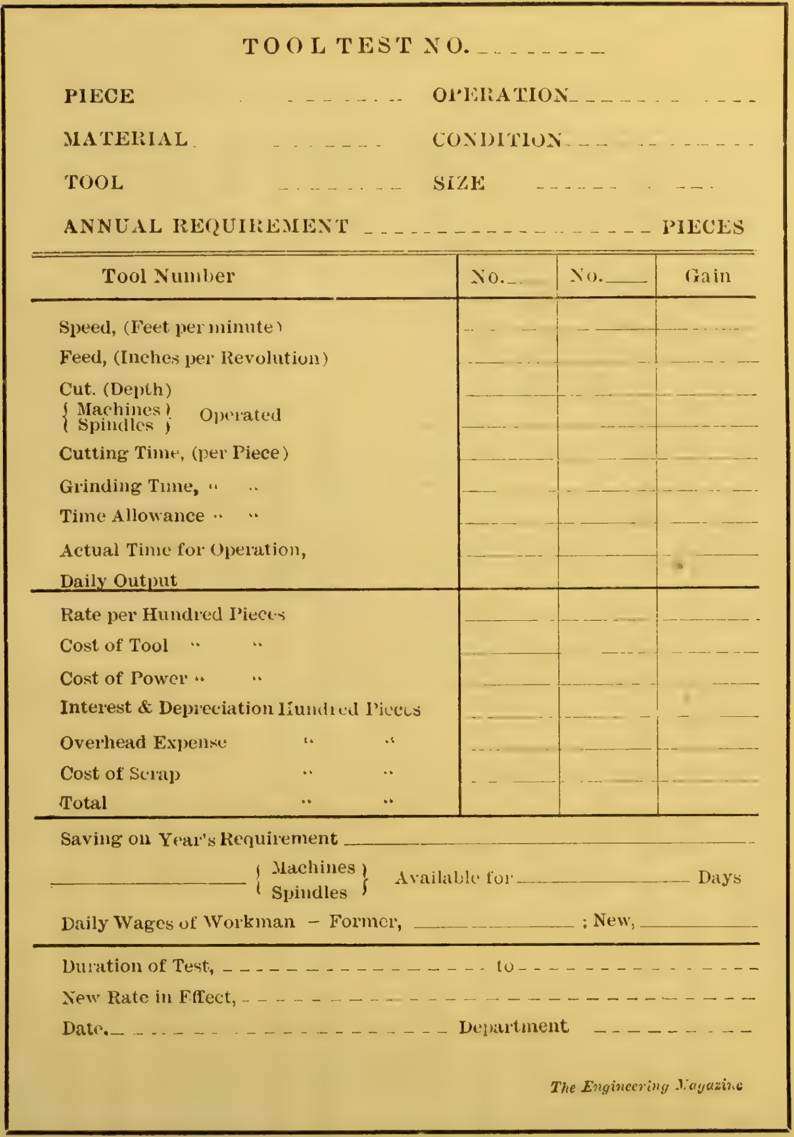
FIG. I. CARD RECORD FILLED IN MOSTLY BY WORKMAN ON THE JOB.

It is convenient to indicate the different tool steels by differently colored cards. Comments made on back of card, Original 6 by 4 inches,



TOOL TEST NO.

PIECE OPERATION

MATERIAL CONDITION

TOOL SIZE

ANNUAL REQUIREMENT PIECES

Tool Number	No.	No.	Gain
Speed, (Feet per minute)			
Feed, (Inches per Revolution)			
Cut. (Depth)			
{ Machines / Spindles } Operated			
Cutting Time, (per Piece)			
Grinding Time, " "			
Time Allowance " "			
Actual Time for Operation,			
Daily Output			
Rate per Hundred Pieces			
Cost of Tool " "			
Cost of Power " "			
Interest & Depreciation Hundred Pieces			
Overhead Expense " "			
Cost of Scrap " "			
Total " "			

Saving on Year's Requirement

{ Machines / Spindles } Available for Days

Daily Wages of Workman – Former, ; New,

Duration of Test, to

New Rate in Effect,

Date, Department

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FIG. 2. RECORD OF DATA AND RESULTS.

Cost of Power, Depreciation and Interest, and Overhead Expense are rarely of sufficient importance to require consideration. Remarks made on back of each card.

Original 6 by 4 inches,

do not take into account all the factors, such for instance as the workman "soldiering" at his job; and make no allowances for variants that may on the whole be of considerable consequence but of irregular occurrence, as for example accidents to the machinery or a shortage in the supply of material. As previously pointed out, all such variants ought to receive due weight in making changes, so that there will be no necessity for "doctoring" afterward. A try-out by the foreman or expert is useful as a check against the calculated output; and so is a count of, not one day's, but say a week's production. Alone they are insufficient.

If no change in the rate were made, in the job under consideration, the earnings of the workman would be $2.87 per day under the new conditions, as against $1.92 under the old. Accepting the principle that the operator should have a substantial (and permanent) increase in pay for his increased exertion, and that he should be consulted in the matter so as to insure an arrangement satisfactory to himself and the management, a conference with the workmen discloses that he will be very well satisfied with an increase of 35 cents a day, which would bring his daily wage up to about $2.25. This would make $1.66 2/3 per hundred. Leaning toward the liberal side, suppose that the rate be fixed at $1.75, allowing the workman a wage of $2.36; the management will still have made a reduction of about 17½ per cent on the item of labor alone. This item however is not the only one through which a saving is made, as will be seen directly. In fact it includes only about a third of the total saving in this particular case. Let us see what some of the other items are.

First may be considered the cost of the tool. Usually little, if any, economy may be expected in this item, except when it is found expedient to use inserted cutters. In this instance however, because of the hardness of the material worked upon, it happens that the cost of the tool is reduced from 3 to 0.8 cents per hundred pieces machined; or a total economy of $5.28 on the year's output.

The question of power is in this instance ignored because of the difficulty of measuring the amount used. If a motor drive is in use, the measuring of the current consumed under both conditions becomes an easy matter. On the whole this item is usually negligible.

The matter of insurance and of interest on capital invested, as well as that of depreciation and repairs, is commonly overlooked in dealing with the high-speed-tool proposition. At times however it assumes an importance that would not ordinarily be suspected. Where the already installed equipment is used with the high-speed tools the higher duty required of the machine wears it out so much more rapidly than before that the item of depreciation usually balances itself, if indeed it be not over-balanced in favor of the old tool. But when the new tool is used in a new machine designed for the heavy duty, the item often assumes proportions sufficiently large to justify attention.

The most important saving in the job under consideration happens to be, not in labor, as is usually the case, but in material scrapped. Ordinarily this is a matter entirely overlooked; and indeed in most cases it is not sufficiently important to justify serious consideration. In this case, however, the rapidly dulling tool formerly did such imperfect work that something like 5 per cent. of the pieces were scrapped; and since each was worth (material only) about $ .25, the loss was considerable. The high-speed tool made it possible largely to eliminate this source of loss, with the result that there was a saving of $ .665 per hundred pieces machined.

Summarizing the various items entering into the total saving, we have the following:

	Self-Hard.	High-Speed.	Economy.
Piece-work rate, per 100 pcs., ...	$2.125	$1.750	$.375
Cost of Tool, " " "	.030	.008	.022
Power, " " "		Neglected.	
*Insurance and Interest, per 100 pcs.,	.072	.049	.023
†Depreciation and Repairs, " " "		Neglected.	
Scrap, net loss, " " "	1.050	.385	.665
Totals..................	$3.277	$2.192	$1.085

On the basis of the year's production, 24,000 pieces, this is a saving of $260.40. Of this amount $90.00 is for labor alone.

The case we have been considering is not a typical one. Indeed it was selected mainly for the reason that it shows clearly what high-speed steel means in cases where ordinary tools are quite out of the question and self-hardening ones unsatisfactory. The use of high-speed tools was here indicated quite aside from the saving to be effected, and it must not be thought that under ordinary circumstances an equally good showing could be made.

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* Based upon 4 per cent. of cost of machines, for time they were actually in use upon this job.

† Though no economy is effected, and on the contrary a loss may be sustained because of the shorter life of the machine, there is an actual advantage in that capitalization is virtually reduced because the two machines become available for other work during 83 of the 261 days they were formerly required.

EDITORIAL COMMENT

MORE than five years ago, before either the British or the American Pacific cable was constructed, this Magazine advocated emphatically the consideration of the northern great-circle route, as by all considerations the best path for a Transpacific cable. In our issue for November, 1899, in a leading article of force and clearness, Mr. Harrington Emerson showed the great advantages of this route, extending by short coast cables from Seattle to Cape Flattery, and thence via Dutch Harbor to Yokohama and Manila, branching to the mainland via Vladivostok. The cost of the construction was shown to be far less than that of the route of long distances and greater depths, while the commercial advantages, both as to trade connections and cheapness of operation, were fully demonstrated. The plan did not appeal to government officials, however, as they had already committed themselves to the fetish of an "all-American" cable, regardless of the fact that those cables which are protected by the joint interests of several great powers are far safer in time of war than those belonging to a single nation.

Now, however, the demand for cable communication with Alaska has resulted in the completion of a large portion of the northern route, precisely as advocated in these pages, and it is rather amusing to find that those officials who turned the plan down in such a summary manner are the ones who step forth into the lime-light and graciously accept all the credit for the plan. All that we ask is that they proceed with the good work and hasten the connection of the Alaskan lines with the Japanese system, confident that the commercial advantages which we advocated five years ago will continue to act with increasing effect over the line of least resistance.

* * *

IT is with feelings of deep regret that we record in these columns the death of Professor Franz Reuleaux, which occurred at Berlin on August 20. Professor Reuleaux was so well-known to American engineers, both by his monumental writings and by his charming personality, that in his death many members of the profession mourn the loss of a personal friend. From his early associations as one of the distinguished group at Zürich, in which were numbered Zeuner, Clausius, and their colleagues, to the severance of his work at the expiration of his forty years of service at the Royal Technical High School at Charlottenburg, Professor Reuleaux stood as the exponent of all that was highest and best in the science and practice of engineering.

As a pupil under Redtenbacher, he found the science of machine design just emerging from the bonds of empiricism, and as a professor and author he joined in giving it its true position as a branch of applied science, based upon rational considerations and broadened into wide fields of usefulness. It is only necessary here to mention the names of a few of his works, as the "Constructor," the "Theoretical Kinematics," the "Applied Kinematics," and a long list of addresses and papers in the technical press and before professional organizations, to recall the services which Reuleaux rendered to the engineering profession. His name will long remain in the Hall of Fame of the engineer as an example of great natural powers directed to high aims, and many who are left behind will mourn him as a master, instructor, and friend.

* * *

While there is at present a lull in work upon the Panama Canal at the Isthmus, with the exception of the continual prosecution of the sanitary campaign, the engineering side of the subject has been transferred to Oyster Bay and to Washington, in connection with the work of the Advisory Board, to which body the fundamental features of the work have been referred for opinion. This Board includes among its numbers probably the most distinguished living members of the engineering profession in connection with waterways and hydraulic problems, and hence every portion of the subject will doubtless be given the benefit of the highest expert opinion available.

Among the American members of the Board are included Major-General Davis and Captain John C. Oakes, both of the United States Army; Brigadier-General Henry L. Abbot, U. S. A. (retired), whose papers upon the hydraulic problems of the canal in this Magazine have attracted much attention, and whose recently published. book, entitled "Problems of the Panama Canal," has placed him in the front rank of the authorities upon the subject; Mr. Isham Randolph, chief engineer of the Chicago main drainage channel; Mr. Joseph Ripley, engineer of the Sault Sainte Marie Canal; Mr. F. P. Stearns, an eminent hydraulic engineer of Boston; Mr. Alfred Noble, past-president of the American Society of Civil Engineers; Mr. W. B. Parsons, of the New York Rapid Transit Commission; and Prof. William H. Burr.

The foreign members of the Board include men who have been most prominently associated with canal and drainage problems in Europe. Among them may be mentioned Mr. William Henry Hunter, of the Manchester Ship Canal, whose important articles in this Magazine six years ago attracted much attention; M. Edouard Quellenec, consulting engineer of the Suez Canal and engineer of the Corinth canal; M. Guerard, engineer of the St. Louis canal and of the Marseilles harbor improvements; Herr Eugen Tincauser, engineer on the Kiel canal; and Mynheer J. W. Welcker, director of the dyke and drainage system of the Netherlands.

In calling together such an eminent body of engineers the President has wisely raised the fundamental problems of the canal to an international position, and upon the decisions of these men the world may well depend, as representing the highest point in the present state of the art of the engineer. Quite recently the President called the Board to him at Oyster Bay, and there impressed upon them the importance of promptness in their work, and after their visit to the Isthmus an early and final report may be expected.

* * *

In Mr. Wallaces's article in our September issue a few errata appeared—partly through oversight in the proof-reading, and partly through the lack of opportunity to receive the author's final revision before going to press. The following corrections are to be noted:—

Page 808, second line from top; after the word "removal" insert "from the summit cut."

Page 808, near bottom, first line under the sub-head "Bureau of Machinery"; for "Contracting the Design" read "Construction and Design."

Page 810, paragraph numbered 5, sub-head D; for "Division channels" read "Diversion channels."

Page 810, paragraph 5, sub-head I; for "Government of town" read "Government of Canal Zone."

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

TELEGRAPH LINES IN AFRICA.

EXTENSIONS OF TELEGRAPHIC COMMUNICATION IN AFRICA IN CONNECTION WITH THE RAILWAY FROM THE CAPE-TO-CAIRO.

Hans von Hellrigl—Zeitschrift für Elektrotechnik.

IT is an interesting fact that in modern exploration work the telegraph not infrequently precedes the railway or even the highway. A wire can be run where a road is a difficult matter, and when a message can be sent it is frequently unnecessary for a man to make a journey. At the same time there is a curious sensation experienced when one realizes that before very long an overland telegraph line will be in working condition from one end to the other of the land once known as the "Dark Continent," but now rather the field of engineering development in nearly every sense in which that broad term can be understood.

In a recent issue of the *Zeitschrift für Elektrotechnik,* Herr Hans von Hellrigl discusses the development of telegraph construction in Africa, and taken in connection with the article by Mr. J. Hartley Knight upon the progress of the Cape-to-Cairo Railway, which appears elsewhere in this issue, an excellent idea of the manner in which Africa is being opened up will be obtained.

When the through telegraph line was planned, in 1898-1899, it was hoped that the whole system would be in working condition by the close of 1904. This expectation has, unfortunately, not been realized, but at the same time excellent progress has been made. In May, 1900, telegraphic communication was open from the Cape as far north as Mafeking, a distance of 1,400 kilometers, while in the northern section the line was open from the Mediterranean southward as far as Fashoda, a length of about 3,500 kilometers. There thus remained to be constructed the connecting portion from the southern boundary of the Egyptian Soudan to Salisbury, the capital of Rhodesia. This stretch of about 6,000 kilometers in length was undertaken by the so-called "African Transcontinental Telegraph Company," an organization founded for the purpose by the late Cecil Rhodes.

As long ago as 1898 telegraphic communication had been opened between Karongo in Rhodesia and the northern extremity of Lake Nyassa, and the extension of 340 kilometers from Karongo to Abercorn, following the boundary between Rhodesia and German East Africa to the southern extremity of Lake Tanganyika was added in the early part of 1899.

The question which has here arisen concerns the carrying of the line northward through German territory. The railway connection, according to present plans, is intended to reach only to the southern extremity of Lake Tanganyika, traffic being carried from thence by steam navigation on the lake. The telegraph, however, must be carried either on the east bank, in German East Africa, or on the west shore of the lake, in the Congo Free State, after which the route to the Albert Nyanza and the Nile is in British territory. As long ago as March, 1899, Cecil Rhodes had an interview with the German Emperor upon the question of the construction of the line through German territory, but the matter does not appear to have been definitely settled. At the present time the northern terminus of the line is at Ujiji, on the bank of Lake Tanganyika in German East Africa.

The construction of the telegraph line, so far as it has been executed, is a matter of some interest. The wires are carried on iron poles, these being usually 5 meters high, in three sections, the total weight being about 72 kilogrammes. Occasionally, when streams are to be crossed, or other wide spans cleared, there are higher towers constructed. Ordinarily the construction party was divided into five sections, the work being usually done by natives. The first gang cleared a way through the forest, staking out the location of the poles, usually about 13 to the kilometer, while the second partly followed and cleared and widened the path. The third gang dug the holes for the telegraph poles, while the fourth party brought the sections of the poles, these each forming a load for a man, and completed the work of erection. The fifth and last party carried the wires, and completed the stringing of the connection. By following this systematic procedure the work was rapidly conducted, when the natural difficulties encountered are taken into consideration.

The question of the extension of the British line through German territory is possibly complicated with the plans for a German line from Dar-es-Salaam, the German port on the eastern coast of Africa, to the interior of the colony, reaching to Tabora, and ultimately to Ujiji, thus connecting with the transcontinental system. It is possible that the final connection of the southern and northern portions of the entire system may be deferred until the construction of a railway line along either bank of Lake Tanganyika, in which case the telegraph line would naturally follow the railway route.

It is possible, however, in view of the constructive difficulties in this portion of the route, that communication may be opened between the present terminals by means of wireless telegraphy, at least over certain especially difficult portions of the route.

Other telegraph lines of interest and importance have been constructed in various parts of the African continent. Portions of what will ultimately be an east and west trunk telegraph line have been constructed, and these will unite the Congo Free State by way of Stanley Falls, with Abyssinia, where an extensive telegraph and telephone system is in operation, and from which three main lines connect to Egypt, to Erythrea and to French Somaliland, the latter line reaching the coast at Djibouti, on the Gulf of Aden.

A telegraph line naturally accompanied the construction of the Uganda Railway from Mombasa to the Victoria Nyanza in British East Africa, and this is being extended around to the west coast of the lake, the ultimate connection being to the main north and south line at some point not yet definitely settled, on the banks of the Albert Nyanza. Branch lines are also planned from the main line, eastward to Uganda, and westward to the Stanley Falls.

Numerous telegraph lines exist along the east coast of Africa, in connection with the Usambara railway, and in the territory of Portuguese East Africa and Mozambique. On the west coast a line follows the Congo river into the interior, and this connects to the submarine cable systems which are carried along the coast and places the region into communication with the telegraph lines of the world.

It is planned in the near future to connect the line of the Congo telegraph to Basaka by a branch from Equatorville, and an agreement has been made between France and Belgium for the introduction of a cable between Kiushassa, at the Stanley Pool on the left bank of the Congo, and Brazzaville on the right bank in French Congo territory. The cost of the cable connection is to be borne jointly by the two governments, and its construction will place the Congo country in direct communication with Europe through the lines from Brazzaville to Loango and Libreville and the coast cables.

The Sahara is now approached by telegraph lines from all sides, there being numerous spurs extending inwards from the various ports on the northwestern coast and from the French Mediterranean colonies. As yet the idea of a trans-Saharan telegraph is in the dim future and it will probably be preceded by applications of wireless communication between a few stations.

From this brief sketch it will be seen to what a great extent the continent of Africa is being covered with a network of lines affording immediate telegraphic communication with points in the interior, and aiding in the exploitation and development of the whole land.

According to the report of the International Telegraph Bureau at Berne for 1903 there were then in operation in the continent of Africa 53,747 kilometers of telegraph lines, or about 33,400 miles, this being miles of route, representing many times that length of wire, while during the year 1904 there were added in Rhodesia alone 4,000 kilometers more, or nearly 2,500 miles.

DISASTERS TO SUBMARINES.

NOTES ON THE CAUSES OF ACCIDENTS TO SUBMARINE BOATS AND METHODS ADAPTED FOR THEIR SALVAGE.

Captain R. H. Bacon—Institution of Naval Architects.

ALTHOUGH there are various opinions at the present time as to the serviceability of submarine boats in actual naval warfare, there is no doubt that such vessels, in their present and in greatly improved forms, will form important portions of the navies of the future. Unfortunately the development of such vessels includes the necessity for many men to incur great risks in manœuvering and experimental manipulation, and there have been several such serious disasters of late to submarine boats in different places that the paper presented by Captain R. H. Bacon before the Institution of Naval Architects upon the causes of such accidents, and the best means of conducting salvage operations is especially timely.

Captain Bacon recognizes at the start that questions of public policy forbid the discussion of full details of construction and operation of submarines, but there are certain well-known principles of construction necessarily involved in all types, and bearing these in mind the subject can be examined intelligently.

"Broadly speaking, there are two classes of accidents that can happen to a submarine boat. First, the admission of water into the interior; secondly, an explosion. Both these have their counterpart in surface vessels, namely, collision and boiler or ammunition accidents. But the confined space and small reserve of buoyancy of the submarine boat intensifies the danger of the result to the crew. And it is this, rather than the frequency of accidents, that has occasioned public comment.

"In the case of admission of water, no help can be expected from water-tight bulkheads, for obviously to keep the vessel afloat each compartment must not have a greater capacity than the equivalent of the reserve of buoyancy; but, further, for such compartments to be effective, only one, namely, the center one, can be allowed the same volume as the reserve of buoyancy, since it is not only necessary to float the boat, but also to afford egress to the crew, and, therefore, the boat must be maintained approximately on an even keel. To do this no compartment except the midship one must exceed in capacity half the reserve buoyancy of the boat; this limitation is necessary so as to allow of a corresponding compartment, the opposite end of the boat being flooded to maintain the horizontal trim. Such subdivision would mean at least thirty compartments, and none except the one in the center of the boat could be more than 3½ feet between the bulkheads. Of course such a subdivision is an impossibility. It may, however, be argued that it would be well to have one or two compartments so as to confine the water to definite portions of the boat, and to leave a certain amount of space for the crew to inhabit in case of accidents. This is a very reasonable contention, but before accepting it we must consider the probabilities of an accident happening, the chances of such an accident occurring in waters where salvage is possible, and, further, the chances of successful salvage to save life under ordinary conditions of sea and weather; all these must be balanced against the ever present inconvenience in daily life of having the boat divided into these three or four compartments. Such subdivision is not merely an inconvenience as regards control and communication, but for another reason it reacts against the efficiency of the boat when actually running on service. One marked feature in practice is the way in which spaces below a certain size affect the normal mental condition of the men. To run a boat successfully everyone inside her should be in an absolutely normal condition; the increased construction of vision and the necessary accuracy of handling argue even greater coolness than in ordinary vessels. For a man's mental condition to be normal, free living space is required; too confined surroundings react on the crew, and by producing a feeling or restriction create a mental tension; hence unless some very strong reasons exist for making living spaces below more confined than absolutely necessary they should be as large as the boat will permit."

In considering the case of accident by water entering the boat, this may occur when the water enters a hatch, or when it gains access by a leak, the former being the more probable cause. All the recent accidents, those of the Russian *Delfin,* the French *Farfadet,* and the British A I and A 8, were due to this cause, and it is to this point that improvements in design should be directed. Automatically closing hatches have been suggested, but while such a construction is possible the danger of any portion of a man being trapped by the closing hatch would entirely nullify and security.

Probably the best protection is the provision of improved methods for enabling the hatch to be closed or tightened from within, with possibly the addition of a supplementary hatch at the base of the conning tower.

Dangers from collision cannot always be avoided, but care in manœuvering may greatly reduce their probability. It is naturally one of the dangers to such boats when in action; in common with practically all other types of war vessels.

So far as accidents from explosions are concerned, these may be caused by the formation of explosive mixtures of petrol and air, due to leaks; or to the accumulation of explosive gases from storage batteries. Captain Bacon also mentions explosions of compressed air reservoirs, and the possible danger from a flooded storage battery. These accidents may be considered as preventable by care in construction and in operation, although the danger of explosion of petrol vapor may be removed by the employment of motors using heavy oils, such as the Diesel motor, which, we believe, is used in certain submarines. Broadly, the danger from explosions is no greater than on board any ordinary naval vessel.

In regard to salvage problems, Captain Bacon discusses primarily the question of saving the imprisoned men, since a boat itself can generally be raised afterwards, sufficient time being given.

"Before adopting any special appliance or constructional complication, suggested solely from the point of view of saving life in accidents, two considerations should be fulfilled: First, the fighting efficiency of the boat must not be seriously affected by it, since the boats are designed primarily for fighting and not for meeting with accidents; and, secondly, that such arrangements when introduced shall be efficient against all reasonable accidents that may happen. It is simple to design a boat to be safe against any particular accident; the impossibility lies in designing one safe against every accident. The commonest device for the release of a crew from a boat is that of providing an air lock and diving chamber, and a hatch that can be opened from the bottom of the air chamber, the pressure of air preventing the water entering when the hatch is open; the crew can then, one by one, dive out and come to the surface. Supposing a sufficient space devoted to such an arrangement, there are two considerations which militate against its success. The hatch must necessarily be in the bottom of the boat, but if an accident happens it is "even chances," even in the uncommon case where the boat is undamaged, whether the boat rests with its fore or after end on the bottom. It is, therefore, an even chance whether the men would, or would not, be able to use this means of egress. Again, it must be assumed that water is present in the boat, otherwise there is no reason that she should not come to the surface, and if this water is present it is again an even chance if the compartment can be got at from the interior of the boat. But further, even supposing this chamber could be used, we have still to consider the effect on the crew of the variation in pressure by suddenly rising to the surface from a considerable depth. It is common knowledge that under pressure the gases absorbed in the blood get compressed, and that sudden release of such pressure allows them to expand, producing large bubbles of gas in the blood, which cause breaks in its continuity; this is productive of the most serious effects on the system, so that, even if the men were able to find egress, in many cases their lives would not be saved. Since, therefore, this system cannot be safely used in deep water, not at all on a soft bottom, and unless duplicated and placed at each end of the vessel, it is useless with a small amount of water in the boat, and quite valueless with a large amount, it is not a fitting on which it is worth wasting much valuable weight and space. Another common suggestion is to provide a detachable chamber into which the crew may climb, which can be freed, and then will float to the surface. A few figures will dispose of the practicability of this idea. Allowing 1½ square feet of space for each man, 11 men will require 16½ square feet. If the chamber were made cylindrical the thickness would be ¼ inch. It would have to be ballasted to keep it upright when floating, and, moreover, must float with a certain reserve of buoyancy to allow of the top being open even in smooth water for the egress of the men. This means that the cylinder would have to be at least 6 feet in diameter, and 7 feet to 8 feet high. This would be an enormous excrescence outside the boat, and greatly increase her submerged resistance, even if further fitted with fair waters to relieve its circular shape, although increasing its size. Its dimensions would quite preclude the possibility of carrying it inside. In addition, the securing arrangements and water-tight doors would add considerably to its weight, and then, in the end, a collision, which is, after all, the most probable cause of accident, would be liable to put it out of gear. Any one who really considers carefully the difficulties of providing reasonable methods of exit for a crew will soon be convinced of the futility of such special arrangements."

SUBWAYS IN CHICAGO.

CONSTRUCTION AND OPERATIVE FEATURES OF THE FREIGHT AND TELEPHONE TUNNELS IN CHICAGO.

Report of the Special Commission.

THERE has been recently much interest expressed in the discovery by the general public and by the municipal authorities that a private corporation has succeeded in constructing more than thirty miles of tunnels beneath the streets of the city of Chicago, and in order that the status of the work might be officially determined a special commission was appointed to investigate the matter. This commission has made a report which contains much matter of interest and some abstract and comment upon the subject may be permitted.

Ostensibly the tunnels were intended to be used merely for the purpose of carrying the wires of the Illinois Telegraph and Telephone Company, and under an ordinance passed in 1899 work was begun. The section of the tunnel was given as 6 feet wide by 7 feet 6 inches high, in horseshoe form, this size being adapted for the passage of workmen and the placing of the wires in position. The company had acquired the control of the patents of the Strowger automatic telephone system, and that system is now in practical operation in Chicago, using the tunnels which have thus far been constructed. In 1901 larger trunk-line tunnels were started, these being 12 feet 9 inches wide by 14 feet high, this section being permitted in order to enable the larger cable reels to be introduced into the system, and avoid interference with the streets and with other underground work. Only a short section of this enlarged tunnel has been constructed, but of the smaller size there have been constructed more than thirty miles, underlying the greater part of the business districts of the city.

"The tunnels are constructed of concrete, 10 inches thick on the crown and sides and 13 inches thick on the bottom. All the main lines, including many of the bypasses and curves at the intersections, were constructed under an air pressure of about 9 pounds. The method of construction was as follows: The bore was dug in the clay for a distance of 20 feet, and about a foot larger all around than the completed tunnel was to be. The 13-inch concrete bottom was then put in place, and on this were placed forms made of 5-inch channel bars in two pieces, and curved to the exact size of the inside of the completed tunnel. Outside of these forms, boards 20 feet long were placed one at a time on each side, and the concrete rammed into the space between the boards and the clay. When the crown forming the key was reached, boards 3 feet long were used. It was afterwards found better to build 15-feet sections instead of 20-feet. The concrete was composed of one part Portland cement, 3 parts sand and 5 parts gravel."

Although, as has been stated, the tunnels were originally intended for the purpose of constructing a telephone system, it was found that the size of the section permitted room for small cars and electric locomotives, and after a considerable portion of the work had been completed, the company announced that it was prepared to undertake the carrying of merchandise, newspapers, mail matter and similar work. At the present time the system is in a position to deliver and convey merchandise to nearly al parts of the business portion of the city, to deliver and remove ashes from power plants, convey baggage from railway stations to distributing points, in short, to relieve the streets of Chicago from a large part of the congestion of the present trucking system, and probably to enable many of the labor troubles inseparable with that system to be eliminated.

The manner in which the work was done is remarkable, in that there was no disturbance of the public highways, the original shafts being dug in the rear of private buildings controlled by the individuals interested in the project, and the tunnels being excavated through the clay which underlies the city, at a depth of about 30 feet, the earth being brought up through shafts at various points and removed at night, so that the magnitude of the work which was going on beneath the streets was not brought conspicuously to the attention of the public.

The method proposed for the operation of the tunnel system for freight transportation is to construct shafts down to the tunnel from the buildings to be served, these shafts being sufficiently large to enable the small cars to be raised to the basement or sub-cellars of the buildings upon elevators. Empty cars may thus be brought up and full ones lowered, and transferred to any part of the city and raised again, and a systematic delivery and hauling business conducted.

Now, after all this work has been done, it is somewhat amusing to find that the official mind is deeply disturbed by these proceedings. In a manner which may be considered as wholly unauthorized these industrious civilians have actually finished a subway system without spending years in discussing plans and schemes, and without interfering at all with other people's business. One is reminded of the criticism of the old military martinet upon the campaigns of the first Napoleon.

"In our day," said he, "we used to march and countermarch, and then we went into winter quarters. Now here comes along a young man, not yet thirty years old, who fights battles in December! 'Tis unheard of."

So with the presumptuous builders of the Chicago freight subways. They have actually ventured to devise and execute a great public work, of which Chicago was sorely in need, far within the time which would have been possible with any unwieldy commission, operating according to beaucratic methods, and the circumlocution offices of Chicago are horror stricken.

All this must now be remedied. It is indeed impracticable to fill up the tunnels and start all over again, but something must be done to call these industrious benefactors of Chicago to account.

"The commission has not been able to

find any authoritative statements concerning capacity of the tunnels to carry the amount of freight claimed, the proper speed for trains, the safe regulation of grade crossings, etc. These questions have not as yet been determined by the company and very probably will not be settled until demonstrated by actual practice. It considers this entire matter should receive the most careful investigation and consideration of competent railroad men.

"It is a matter of great concern to decide how these tunnels shall be regarded, whether as public highways or as the premises of a private corporation. On the point of view taken by the city will depend the solution of the problem of safeguarding the public or employees of the company against crime, accident, fire, breaking down of power and light plants, etc. There is no provision for emergency exits from the tunnels in case of accident.

"The control and supervision by the city of the work of building these tunnels has been lax when compared to similar work done for private individuals or corporations. Ordinary practice demands a definite official plan and specification, and a sufficient force to properly supervise the work at all points and at all times; while in this case there were no definite plans and specifications, and there was but one city representative in the supervision of the entire work. The commission finds the city records of the work very incomplete, for example, it has been unable to find any written specification either for the cement or the concrete. It has been unable to find any official survey showing the exact location of the tunnels."

While these solemn proceedings have been ponderously getting under way the tunnel builders have been busily at work, and unless the commission can get its work in very promptly there will be a much greater extent of tunnel construction completed than when their deliberations were begun. It is to be hoped that nothing will really be done which can effectually block the full completion of this most important enterprise, and the only matter for regret is that similar methods of rapid and quiet construction cannot be carried out in other great cities, to the great benefit of the public and the ultimate discomfiture of the ancient and unscientific system which depends upon the use of heavy trucks on the surface.

THE CAUSE OF BRITTLENESS IN STEEL.

INVESTIGATIONS INTO THE INFLUENCE OF COMBINED NITROGEN UPON THE PHYSICAL PROPERTIES OF IRON ALLOYS.

Hjalmar Braune—Revue de Métallurgie.

AMONG the various physical and mechanical properties of the numerous iron alloys grouped under the generic name of steel, that of brittleness, or as the French call it, fragility, has caused much perplexity. Two products, apparently the same in chemical composition, and in visual constitution will be found to be quite different in behaviour under shock, one being tough and resistent while the other breaks without warning. Attempts to devise physical tests to discover the causes of this action, or at least to separate the good material from the bad, have met with but partial success, although various forms of drop tests are now realized to be of much value in commercial investigations. Examinations of portions of structures which have failed in service have not given any very clear indications as to the causes of sudden breakages, and it has been felt that some better knowledge of the origin of the property of brittleness would have to be discovered before the practical side of the subject could be pursued further to any material advantage.

We now have a paper in the *Revue de Métallurgie,* by M. Hjalmar Braune, giving a theory of brittleness based upon his investigations of the past six years, this paper being of a preliminary nature, and to be followed by a more detailed account of the experimental researches upon which it is based.

Briefly, M. Braune maintains that brittleness is due to the presence of combined nitrogen, taken up by the iron during various stages of its manufacture. The nitrogen appears to be combined entirely with the iron itself, with the ferrite, forming what may be called a nitrogenized iron; the carbides such as the cementite being entirely free from any nitrogen. This nitride of iron appears as a solid in solution in the ferrite, and acts to lower its point of fusion and at the same time diminishes its capacity for dissolving carbides of iron. In this way the nitrogen exerts a marked influence upon the quality of the metal, whether it be a soft iron, or a hard steel or cast iron.

These statements may be proved by a few simple experiments. A test piece of iron or steel of the highest quality is placed in an atmosphere of ammonia, and raised to a temperature of 800 degrees C. for a period more or less prolonged. These pieces are then annealed in sand, to permit the combined nitrogen to become homogeneously distributed through the metal. The behaviour of pieces thus treated, when tested, shows very clearly the influence of the nitrogen upon the resistance. When the content of nitrogen reaches 0.07 to 0.08 per cent. the elongation rapidly diminishes, and becomes discontinuous, while for higher percentages of nitrogen the ductility of the metal practically disappears. In some instances the surfaces of the test pieces became covered with fine cracks, these effects appearing in pieces in which the annealing had not been sufficiently prolonged, so that the greater portion of the nitrogen remained near the surface.

The effect of the presence of the nitrogen may also be observed by making a metallographical examination of the test specimens. The original untreated metal showed a constitution composed of large cells of uniform surface. Under the presence of nitrogen the appearance of these cells becomes modified, parallel striae of corrosion appearing, while the dimensions of the cells continually diminish. Some of the cells retain their original appearance, while others become completely granulated. Some are partly modified and it is possible to perceive the manner in which the passage of the degradation from one cell to another is resisted. When the content of nitrogen approaches 0.07 to 0.08 per cent. the cells become very small, scarcely one-tenth of their original size, and at the same time the cement which fills the separating spaces between them increases in thickness. When this structure is developed the metal has become wholly brittle. If the nitrogen content attains 0.2 per cent. the cellular structure wholly disappears and appears only a series of dark lines, giving a more or less characteristic pearlitic aspect.

The cellular structure appears to bear a distinct relation to the ductility of soft iron. The larger the cells, the more ductile the metal. The cement which forms between the cells contains the impurities in the metal. A content of nitrogen as high as 0.07 per cent. very rarely appears in commercial products, but in very soft irons, particularly in the products of Lancashire, a very much lower percentage of nitrogen will suffice to render the metal hard and brittle.

The influence of nitrogen upon hard steels is also very distinct. M. Braune discusses the behavior of a steel containing 1.15 per cent. of carbon, when given increasing quantities of nitrogen by heating in an atmosphere of ammonia. At first there is a slight increase in resistance and reduction in elongation; then, suddenly, between 0.03 and 0.035 per cent. of nitrogen, the elongation disappears entirely, the metal becomes completely brittle. For a steel containing 0.50 per cent. of carbon the critical proportion of nitrogen corresponding to the disappearance of ductility is 0.040 to 0.045 per cent., while for a steel of 0.02 carbon this effect is produced by 0.050 to 0.060 per cent. of nitrogen. In every case the sudden attainment of brittleness corresponds to a change in the structure.

A percentage of 0.060 nitrogen is very rare in commercial steels, but 0.030 to 0.040 per cent. frequently appears. For this reason hard steels become brittle much more easily than softer grades, since the proportion of nitrogen required to cause the effect occurs more frequently in practice.

Nitrogen appears also to produce a considerable effect upon tempered steels. The nitride of iron in such cases, appears in solution in the martensite, as it does in the ferrite for the annealed steels. The influence of nitrogen upon the electric and magnetic properties of steel is also distinct. In the case of soft iron the coercitive force and the hysteresis are increased.

In commenting upon these remarkable researches of M. Braune, M. Le Chatelier observes that their importance will be evident to every metallurgist. The appearances noted in the metallographic observations of M. Braune have been noticed before, but it has remained for him to discover their origin. An interesting fact is that the fixation of the nitrogen by the iron does not occur directly by a combination with the nitrogen of the atmosphere, and the presence of a basic slag appears to be necessary as a reducing medium. This corresponds closely with the process of the formation of the cyanides, and indeed it has already been observed that blast furnaces which produce much cyanide of potassium also produce an inferior quality of iron. The nitrogen is acquired by the metal principally in the blast furnace and in the basic converter.

The experiments of M. Braune show that the fixation of the nitrogen is effected more readily from ammonia than from the cyanides. The ease with which the cyanides are transformed into ammoniacal compounds in the presence of moisture renders it probable that the vapor of water may be an intermediary in the introduction of the nitrogen into the metal. This view is confirmed by the experience of M. Guillet in the cementation of nickel steel, it appearing that the use of a moist cementing material is injurious. With a dry material for the cementation the interior of the case hardened pieces shows no brittleness, which is not the case with a moist substance.

The importance of these studies cannot be over-estimated, and if, as appears probable, M. Braune has discovered the true cause of brittleness in iron and steel, the way to prevent the combination of nitrogen with the metal will doubtless be found by practical metallurgists and manufacturers. After the way has been blazed, every succeeding traveler broadens the path, and in this, as in other departments of applied science, the operative departments of an industry are prompt to avail themselves of the discoveries which are made in the laboratory. If the cause of brittleness has actually been discovered, its removal is only a matter of time, and the far-reaching consequences of the discovery cannot now be limited.

HYDRAULIC POWER OF THE APPALACHIAN REGION.

POSSIBILITIES IN THE HYDRO-ELECTRIC DEVELOPMENT OF THE WATER POWERS OF THE SOUTHERN SECTION OF THE UNITED STATES.

Dr. F. A. C. Perrine—American Institute of Electrical Engineers.

AMONG the discussions of natural resources which are now so general in progressive countries may be noted the valuable analysis of the available water power existing in the southern part of the United States, presented as a paper before the American Institute ot Electrical Engineers by Dr. F. A. C. Perrine, and some abstract of this article is given as bearing upon a subject of much importance.

The watershed from which the hydraulic power is derived, belonging broadly to the Appalachian region, includes the Shenandoah, Greenbrier, Blue Ridge, Black, and Great Smoky mountains. Here the rainfall ranges from 35 to 60 inches, there are no difficulties from ice or snow, and there is a well defined fall line above which, in the mountain region, there are numerous opportunities for high heads, while between the fall line and the mountains lower heads are available. By the introduction of modern hydraulic and electrical machinery these sources of power may be developed and applied for manufacturing industries, mostly in connection with the work of their immediate vicinities, thus avoiding the cost and inconveniences of long-distance transmissions, besides aiding in building up the sections in which they are located.

"The principal rivers of the Southeastern Appalachians whose drainage basins need to be considered are the James, Roanoke, Staunton and Dan rivers, in Virginia; the Cape Fear, Yadkin and Catawba, in North Carolina; the Catawba, Broad, Saluda and Savannah, in South Carolina; the Oconee, Ocmulgee, Flint and Chattahoochee rivers, in Georgia, and the Talapoosa, Coosa, Tuscaloosa and Tombigbee rivers of Alabama. There are many tributaries and some of the rivers change their names from source to mouth.

"The northernmost region selected for study is the drainage basin of the James River, having at Richmond an area of about 10,000 square miles. This river gathers its waters from streams flowing northeasterly and southwesterly among the Allegheny, Shenandoah and Blue Ridge Mountains and carrying them entirely across the State of Virginia in a general easterly direction empties them into Chesapeake Bay. The fall line is not reached till at Richmond, where there is an abrupt descent of 84 feet to the tide level just below the city. The James drains an old, well cultivated portion of the country, having an average rainfall of about 41 inches. The minimum run off is 0.20 second-feet per square mile, and the maximum 20 second-feet. An average of 0.35 second-feet may be expected over a three months' period. Toward the headwaters the variation of flow is even greater than nearer the mouth, on account of the fact that the mountains here are low and little snow falls upon them, and they are largely denuded of trees. The average fall of the James from Richmond to the headwaters is about 4.25 feet per mile, excluding the sharp fall at Richmond; in consequence of this rapid flow, exhibiting many opportunities for power development, as the fall is uniformly distributed along the river.

"The Cape Fear River drains a region in the center of North Carolina. Although the watershed is principally covered with clay and sand and comprises pine and oak forests and agricultural land, and in spite of the fact that there are no great falls in its course, except at Smileys Falls, still it is one of the most completely developed power rivers of the South. The rainfall over this watershed averages 50 inches, the greatest fall being in the spring and summer. The monthly average run off is not more than 0.12 second-feet. On the other hand, the floods are very severe, running from as high as 15 second-feet in May to 20 second-feet in January. That a stream with these difficulties to be encountered should have been so well developed shows plainly the importance of a ready market in problems of power development, and the effect of even an unreliable water power in developing manufacturing in a country where the conditions of market, raw material and unsatisfactory labor are favorable.

"The Yadkin River of North Carolina, or the Great Pedee of South Carolina, drains above where it crosses the fall line at Cheraw, S. C., a territory of about 9,700 square miles. Except in the rapids at Cheraw and at the Yadkin Narrows, 55 miles above, there are no important falls, though there are on the watershed a number of opportunities for development by high dams forming storage reservoirs. The rainfall in the mountain region along the headwaters of the Yadkin averages in excess of 55 inches, but over the greater portion of the watershed it amounts to about 46 inches. For the average year the run off is at a rate no lower than 0.32 second-feet. The floods frequently run as high as 30 second-feet, but with few monthly averages rising above 5 second-feet per square mile. The course and drainage area of the Catawba are much similar to those of the Yadkin. Near Camden, S. C., it crosses the fall line; just above are not only the customary rapids, but a few miles further north one of the most remarkable power sites in the South, a total fall of over 150 feet being available for development.

"The fall of the river is not so gradual as the Yadkin, but concentrated in falls, many of which are available for developments of considerable size. The drainage area at Camden is about 5,000 square miles; in the upper half of this territory the rainfall averages about 50 inches and in the lower half about 45 inches. Almost the whole territory is heavily wooded and in consequence the run off is comparatively uniform.

"West of the watershed of the Catawba lies the Broad River, which rises in the Blue Ridge Mountains east of Asheville and flows southeasterly to Columbia, where it joins the Saluda to form the Congaree.

The latter flows into the Wateree and forms the Santee. There is no point at which the Broad crosses the fall line, but it lies altogether in the uplands. The slope is great, averaging about 4.5 feet per mile for 140 miles from its mouth. A number of favorable opportunities are presented for development, notably near Alston, S. C., and near Gaffney, S. C. The drainage area at Gaffney is approximately 2,000 square miles and at Alston about 4,600 square miles; the total drainage area of the watershed is about 4,900 square miles. The soil over the watershed is generally sandy and a large portion is wooded; in consequence the run off is well distributed, not having been found to fall below 0.35 second-feet per square mile.

"The Savannah River, which at Augusta drains a territory of about 7,300 miles located almost equally in South Carolina and Georgia, promises to become the source of some of the most important water powers in the South, not only because the stream flow is good and the shoals well adapted to development, but particularly from the favorable economic situation of the water power sites. The territory on both sides of the river is an important cotton growing section and its adaptability for mills has been well proved; in fact, Augusta, Ga., is the largest cotton manufacturing city in the whole South. The industries of that city have been built up about a 50-foot fall in the Savannah, at that point where the river crosses the fall line. The minimum flow will run as low as 0.50 second-feet for from four to six months. The maximum is about 25 second-feet.

"The middle portion of the State of Georgia is drained by the Oconee and Ocmulgee, which at Milledgeville and Macon, respectively, cross the fall line—a territory of about 6,000 square miles. The rivers are comparatively steep and present a number of opportunities for power development. The flow is comparatively low, often during several months of a year falling to as low as 0.2 second-feet. The maximum flow of 20 second-feet occurs in the spring.

"To the southwest lies the drainage area of the Flint River which crosses the fall line at Albany and follows the Blue Ridge Mountains practically to the end in a rapid flow. This river presents the anomaly of frequently being at its lowest during November, a great disadvantage in a power river, as the yearly load curve of most industries is generally rising at that time.

"The last four watersheds described are headed in the Blue Ridge Mountains which run southwest through Georgia. Across the mountains and running parallel to them is the watershed of the Chattahoochee River which runs rapidly down between the lower extensions of the Blue Ridge and Great Smoky Mountains. In consequence of being located almost entirely in the mountains it presents many desirable characteristics as a power stream. The minimum run off falls to a rate of 0.25 second-feet, and the flood is about 20 second-feet."

ELECTRIC SMELTING.

A DISCUSSION OF RECENT PRACTICAL ADVANCES IN THE ELECTRO-METALLURGY OF IRON AND STEEL.

R. S. Hutton—Society of Chemical Industry.

WITH the development of electro-metallurgical processes in other parts of the world the possibility of applying the methods of electric smelting of iron and refining of steel to the industry in Great Britain is attracting attention. In a paper recently presented before the Manchester section of the Society of Chemical Industry Mr. R. S. Hutton shows that the position of England in this respect is by no means so discouraging as some would believe. Incredulity in this respect is largely based upon the fact of the limited water power available, but it must not be forgotten that the power cost is but one element, and not always the controlling one.

"Many leading electrical engineers have published minute data as to the cost of power generation, but only for electric lighting, traction and motor purposes. These cases, however, are so entirely different in character from those we are concerned with that no definite conclusions can be drawn from this evidence. The average power station is fortunate to get a 15 per cent. load factor and overjoyed with 30 per cent., whereas in nearly all electro-chemical works the manufacture is continued night and day throughout the year, and the load factor may be taken as 100 per cent. If one may judge from the evidence of those few who have had actual experience in electro-chemical industries using steam power, a figure of £6 to £8 for the horse power year is quite attainable under such conditions. With producer gas this may probably already be brought down to £4 in Great Britain. For the sake of comparison, it may be pointed out that although in some few places in the Alps and Norway a figure as low as 17s. per horse power year has been attained, water power is very seldom to be obtained so cheaply. At Niagara the price of supply to large consumers varies from £3 11s. to £4 3s. and at Rheinfelden reaches £6 for the horse power year.

"So far as blast furnace gas is concerned, no very sure data are available for similar industries. The supply of cheap gas power is likely to prove so beneficial to Great Britain in the application of the industries we are about to consider that it is earnestly to be hoped that those who are concerned in the construction of large gas engines will be led to take an interest in these developments. With their co-operation the number of remunerative electro-chemical industries may be very largely increased in England."

There does not appear to be any immediate probability of the introduction of electric methods for the reduction of iron from the ore, but Mr. Hutton gives some interesting points about the relations of electro-thermic processes to the present smelting methods.

"The application of the electric furnace to the metallurgy of iron, with the exception of some few small-scale experiments, which are more of historical than technical interest, may be said to be largely founded on the experience gained in the manufacture of calcium carbide. Carbide furnaces have been and are being largely used for the production of rich ferro-alloys such as ferro-chromium and ferro-silicon, and in this way electro-metallurgy has already been of considerable service to the steel industry. As the production of calcium carbide became less and less remunerative, and as the demands of the market for these ferro-alloys became satisfied, definite attempts were made to tackle the problem of the direct reduction of iron ores.

"It might seem to be rather a hopeless task which the electro-metallurgist has thus set himself; for direct competition with the blast furnace is obviously out of the question so far as our own and probably all other present iron-producing countries are concerned. On the other hand, there are certain advantages which can be gained by electric heating, and, although the electric reduction of iron ores is at the moment unremunerative, we may expect to hear more of it in the future, when the general development of electric furnace construction is more advanced.

"Every ton of pig iron produced in the blast furnace requires very nearly one ton of coke for its production. Of this amount only one-third is necessary for the chemical reduction of the ore, the balance being employed in producing and maintaining the requisite temperature. This two-thirds of the fuel supply can be replaced by electric heating.

"In actual practice, so far, only the simple case of reducing the ore and allowing the carbon monoxide to pass away unused has been tried. Various methods have, however, been proposed by Héroult, Harmet and others for utilizing the total heat of combustion of carbon. Under these conditions it should be possible to reduce iron ore with a much smaller power expenditure. The perfecting of methods along these lines is a matter for the future."

In considering the question of the electric production of steel the matter should be examined on its own merits, and not in connection with the ordinary processes. So far as the matter of power is concerned, the results of the investigations of the Canadian commission show the power expenditure per 1,000 kilogrammes of steel to range between 500 and 1,000 kilowatt hours, the lowest expenditure being that of the Kjellin induction furnace, which was charged with molten pig and cold scrap, while the largest power expenditure occurred when the charge was cold.

More important than the power consumption, however, is the quality of the steel produced by the employment of electric refining processes.

"In the first place, there seems to be good evidence to show that steel, equal in quality to the best Sheffield crucible steels, can be produced in the electric furnace. This can be accomplished either in such a furnace as that of Kjellin which, in its present form, is used almost entirely for melting up carefully-chosen raw materials, and does not rely on any considerable refining of the material. On the other hand, with the Héroult furnace such a product can be obtained starting with almost any grade of raw material; this process relying essentially on its capability of rapidly and completely refining pig iron or ordinary scrap steel. The economical advantages of using a cheap grade of raw material for producing high quality crucible steel will doubtless tell in favor of such a method. It is largely to such possibilities of refining and to the relatively high cost of fuel per ton of product for the manufacture of crucible steel, that the electrical processes owe their advantages.

"From the investigations of the Canadian commission it appears that in nearly all cases the whole operation of melting and refining the raw material has been effected by electric heating. In Great Britain where coal is cheap it is almost certain that much of this heating could be more economically carried out by the combustion of fuel. In the case where molten iron or low grade steel can be run into the electric furnace it will be seen that the power expenditure required for refining it and bringing up its quality to that of a crucible steel is indeed very low. Along such lines as these, the electric furnace may be expected to find still wider application than to the manufacture of high grade crucible steel."

THE METALLURGICAL CONGRESS AT LIÉGE.

RECENT DISCUSSIONS OF CURRENT METALLURGICAL PROBLEMS IN CONNECTION WITH THE LIÉGE INTERNATIONAL EXPOSITION.

Leon Guillet—Le Génie Civil.

WE have given elsewhere in this issue a fully illustrated account of the engineering features of the international exposition now being held in Liége, Belgium, and, following the custom usual with such exhibitions there have been held various technical congresses and scientific gatherings, concerning which reports are now beginning to appear. In recent issues of *Le Génie Civil* is given an excellent summary of the proceedings of the Congress of Metallurgy, from the pen of the well-known metallurgist, M. Leon Guillet, himself an active contributor to the work of the congress.

The congress, which was attended by about 1,600 delegates, including some of the most eminent metallurgists and engineers from Belgium, France, Germany, England, etc., had its work divided into five departments, treating of groups of metallurgical work. The first section considered problems relating to large operations, such as the manufacture of pig iron and of steel, the production of power from furnace gases, the utilization of slag, etc. The work of the second section related to special methods and progresses, such as the manufacture of alloy steels, electrometallurgical processes, and the like. In the third section there was discussed the treatment of iron and steel products, such as the heat-treatment of steel, and the effects of rolling and mechanical working of the metal. The fourth section was devoted to the study of metallography, while the fifth took up processes having an indirect relation to metallurgy, such as the brazing and welding of metals, etc.

It is impracticable, within the space here available, to comment upon all the papers submitted before the congress, but some of the more important communications may be noticed. Thus M. E. Bian, the director of the iron works at Eich, in Luxemburg, described the method which he has found satisfactory for purifying the gases from blast furnaces, rendering them suitable for use in gas engines. This apparatus consists of a cylindrical chamber filled half full of water, and containing a shaft carrying a number of disks of metallic netting, these disks being kept in constant rotation. The gas, passing through these, parts with its dust and other matter in suspension, and the disks are continually washing themselves in the water, this latter being constantly renewed.

An interesting matter in connection with the work of the first section was the discussion of the Gayley dry-air blast for blast furnaces. The correctness of the theory of the process is fully borne out by the facts developed in the discussion. Thus a table prepared by M. Divary, of the Creusot works, shows that the fuel consumption of a furnace under his observation bore a close relation to the hygrometric condition of the atmosphere. Taking the fuel consumption in January as a base, there being 6.3 grammes of water per cubic meter of air, and the daily production of the furnace being 90 metric tons, there appeared in July, when a cubic meter of air containing 13.6 grammes of water, an excess consumption of 133 kilogrammes of coke, while the output of the furnace fell to 70 tons per day. The results for other months showed a close correspondence as to the variation in coke consumption and in iron production with the variation in the proportion of moisture in the air, these figures agreeing closely with those observed by Mr. Gayley at Pittsburg. It is intended to introduce the refrigerating process of drying the air at the Creusot works, as well as in other establishments in Belgium and Germany.

In discussing the theory of the dry-air blast, M. Le Chatelier showed the injurious action of moisture in the air in connection with the presence of sulphur in the iron. By the use of air which is free from moisture any sulphur which is present is converted into sulphurous anhydride, which is entirely absorbed by the limestone in the upper zones of the furnace, where iron itself has not yet reached the spongy condition in which it can take up the gas. The sulphur thus passes off entirely in the slag, a condition which does not occur in the presence of moisture.

The much disputed subject of slag cements came up for discussion at the congress, and Prof, Wedding, of Berlin, expressed himself of opinion that slag Portland cement, made by re-calcining and grinding briquettes made of granulated slag and lime, does not differ chemically from ordinary Portland cement, while the results of mechanical tests are entirely comparable.

Passing to the work of the second section, this included discussions upon special alloy steels, M. Guillet himself furnishing a classification of these products, according to the manner in which the added metal combines with the iron and with the carbon. M. Guillet gave several diagrams showing the influence of the different constituents upon the properties of resistance to rupture, to shock, to elongation, and upon hardness, these enabling a general idea of the effects of the various constituents to be determined and compared. Referring to the ternary steels, these including those containing iron, carbon, and one other constituent, M. Guillet says that the nickel and the manganese steels may sometimes take the place of carbon steels; that the polyhedric steels should have an important industrial future, if the price can be brought sufficiently low; that the tungsten and molybdenum steels have shown themselves of great value for high-speed tools; and that there is apparently no practical use for the graphite steels.

So far as the interesting subject of electrometallurgy is concerned, the principal point brought out at the congress was the fact that the well known projectile works of Jacob Holtzer, at Unieux, has put into service a steeel refining furnace of 1,000 kilowatts, capable of producing 7,000 to 8,000 kilogrammes of steel at a charge.

In connection with the works of the section devoted to processes of treatment of iron and steel, mention may be made of the researches of Hadfield upon the effects of low temperatures upon alloy steels, already noticed in these columns; and of the paper of M. Creplet, upon the application of electric power to the driving of rolling mills.

Of especial importance was the paper of M. Le Chatelier, in the fourth section, upon the subject of metals and alloys by the methods of metallography. M. Le Chatelier discusses the methods of polishing the surface of the metal to avoid surface hardening, describing the preparation of the emery and alumina for working the surface, and the use of various solutions for etching the polished metal. The use of picric acid, originating in the laboratory of M. Le Chatelier, is now well known, but a later method in the use of heated saline solutions containing an oxidizing substance. By using a 25 per cent. solution of caustic soda with 2 per cent. of picric acid, heated to 100 degrees C., the cementite is attacked, without any action being produced upon the other constituents.

In the production of the microphotographs M. Le Chatelier prefers the Nernst lamp to the mercury arc, and the details of his microscopic apparatus have been worked out with great care. After all the care which can be taken, much depends upon the skill and judgment of the operator, and in this, as in other departments of investigation it is impossible to be assured of uniform results.

In the auxiliary metallurgical subjects attention was directed at the congress to the use of the oxy-hydrogen and the oxy-acetylene blowpipes for the welding of metals. There appears to be no doubt that satisfactory welds may be made with either apparatus, and the decision from the industrial viewpoint depends mainly upon the cost. The use of electrolytically produced gases is of interest so far as the oxy-hydrogen apparatus is concerned, but the advantage in point of cheapness appears to lie with the oxy-acetylene blowpipe.

ENGINEERING WORK IN CHINA.

PRESENT CONDITIONS OF CONCESSIONS FOR RAILWAY AND MINING DEVELOPMENTS IN THE CHINESE EMPIRE.

C. D. Jameson—Engineering and Mining Journal.

IT is well understood that the Chinese Empire is rich in mineral deposits, while the large population and extensive internal commerce renders it a desirable field for the development of railway enterprises. At the same time it is known that there are local difficulties connected with the improvements of these natural and commercial resources, and that outside interference, as it is considered, is not welcomed, even though it be to the advantage of the country. The present status of the subject of Chinese concessions is discussed in a paper by Mr. Charles D. Jameson, in a recent issue of the *Engineering and Mining Journal,* from which we make some abstract.

"To-day the Chinese, both Government and people, strongly oppose the granting of any further concessions for railways or mines to foreign syndicates. Not only this, but the Chinese Government is making an effort to cancel some of the existing concessions and to purchase others from the present owners. Broadly stated, the reason for this is that not one of the syndicates holding concessions in China has conformed, in either letter or spirit, to the terms of the agreement under which the concession was granted.

"Concessions in China are of most recent origin; none of them is yet ten years of age, and the majority date from 1898. Of her own free will China never granted a concession to a foreigner, and never wished to do so. The existing concessions were obtained by pressure brought to bear upon the Chinese Government by the government representing the nationality of the syndicate, and by money paid to individual officials for their good will and influence. (There are exception to this, which I refer to later). Thus China has been more or less forced into the granting of the existing concessions by the various European powers in order to balance or counterbalance the political situation in the Far East. Even this condition of affairs might have continued possible if, after the concessions had been granted, the various syndicates had carried out the terms of their agreements and had developed the concessions in a *bona fide* manner. In every instance, as soon as the original concession has been granted in accordance with a definite and written agreement as to terms, the syndicate has commenced a campaign to have the terms modified, and more modified—always to the betterment of the syndicate and the detriment of China."

An important difficulty which exists in connection with the work of a syndicate of investors in China is the fact that the empire has not yet been admitted to the so-called family of nations upon terms of equality, so that the intercourse between China and foreign governments must be regulated by the terms of international treaties. These treaties generally contain the so-called favored nation clause, by which any advantage granted to any nation by China must also be granted to the nation included in the treaty. The result is that several nations can easily succeed in "rigging the market," so to speak. Concessions are granted to several nations, such as France, Germany and England, upon equal terms. Then one country after the other succeeds in making some slight modification of the conditions, not much in itself, but always to the benefit of the syndicate, which includes all the nations. Each nation tries this game, and all benefit, while China as a nation loses.

"The story of the Hankow-Canton railway concession to the American-China Development Company merits a rehearsal here. China feared the international complications which might arise from the granting of concessions to the larger European powers, owing to their lust for territorial aggrandizement. The Peking-Hankow line was granted to the Belgian syndicate (upon their plea that Belgium was a small power, with no territorial ambitions in the Far East). After the granting of this concession China's confidence in European powers was not increased, when it was found that the Belgian syndicate was three-quarters French; that the greater part of the money to be used was French, and that Russia had satisfied the French investors as to the perfect security of the undertaking. Therefore the southern half of China's great trunk line was not given to the Belgian syndicate, although every effort was made to bring this about. This piece of railway (Hankow to Canton) was given to the American-China Development Company. This company had done but little work to obtain this concession, and probably no money had been used. China wished America to have it in order to save herself from others. In making this contract there was a written and verbal agreement that the company and capital were to be *bona fide* American.

"In 1901 the American company had sold to the Belgians (or to those back of the Belgians) a majority of the shares which gave them the practical control of the affair; and, while the company still acted under an American charter with an American president and general manager, yet the actual management was the same as that of Peking-Hankow railway. American management in China has been most unfortunate.

"When the predominance of Belgian control became evident to China, a threat was made by the Chinese to cancel the concession. Whether this would have been possible or not is now beside the question; they succeeded, however, in making things so unpleasant for the American company that China at last received notice that all the Belgian shares had been repurchased by a Morgan group of capitalists, and that the company was *de facto* American. This occurred in 1904."

As an example of the manner in which Chinese concessions are exploited, Mr. Jameson discusses the Peking Syndicate, Limited, of London. This concession, ratified May 1, 1898, was the first *bona fide* concession for mining ever given to a foreign syndicate by the Imperial Government of China. It gave exclusive rights to work the southern half of the province of Shanis, and the portion of the province of Honan north of the Yellow river for coal and iron, this being an area of 25,000 square miles of the richest coal and iron mines in the world.

"For seven years this syndicate has held this enormous territory and not one ounce of coal or iron has it mined. The most available coal and iron deposits are in southern Shansi and northern Honan. In the district of Tse-Chow, southern Shansi, there is practically an unlimited deposit of high-grade anthracite coal lying 3,000 feet above the alluvial plain. This coal is so located that it could be mined by adits; it lies nearly horizontal, and the adits would drain themselves. The thickness of the coal in the main seam is such that ordinary coal cars could be run to the face of the workings and the coal loaded for transportation at once. The coal is in perfect condition, and contains so little dust that no cleaning would be required.

"But to reach this elevation of 3,000 feet above the plain requires a railway of 30 miles, which for a standard steam railway complete would cost £500,000. The grade would be uniform, and the road bed being mostly in rock, the cost of maintenance would be low. But this railway has not been built, and this immense visible coal supply has not been tapped. An electric railway from Tse-Chow to the plain would cost less than £200,000, and the cost of operation would be low."

The Peking Syndicate has sunk shafts at the foothills to tap a deposit which is probably 600 feet below the surface, and has built about 90 miles of railway from the shafts to Tao-Kou on the Wei river. It has also succeeded in getting the Chinese Government to guarantee its bonds for the railway at 5 per cent.

"From the standpoint of the Peking Syndicate shareholders there has been over £1,000,000 expended since the granting of the concession, and no coal or iron has as yet been mined. In the meantime, however, alien railways have been, or are being constructed on the north, south and east sides of the ceded territory; none of the coal or iron can be put on the market without paying transportation rates over railways owning, directly or indirectly, competing mines of bituminous coal. None of the bituminous coal in the Peking Syndicate area is so located as to be marketable for many years.

"While no royalties or profits have accrued to China as yet from the many valuable concessions granted by it to foreign syndicates, yet the original syndicates have reaped a rich harvest in the jugglery of the shares in the markets of London and Paris. These few examples of the methods pursued by foreign syndicates in China may explain the lack of desire and enthusiasm on the part of the Chinese to the granting of additional concessions."

THE UTILISATION OF PEAT.

METHODS OF PREPARING PEAT FOR USE AS AN INDUSTRIAL FUEL ON A COMMERCIAL SCALE.

Engineering.

THE interest which is being taken at the present time in the possibilities of peat fuel renders an editorial in a recent issue of *Engineering* timely and interesting. Especially important is the development of peat to the industries of Ireland, since the absence of coal acts to retard very materially the commercial success of manufacturing undertakings. The peat bogs of Ireland, covering areas of hundreds of miles, in beds of 20 to 30 feet in thickness, represent an enormous mass of fuel, requiring only some method of preparing it to cause it to assume commercial importance.

"In composition, peat partakes much of the nature of wood. When dried, it is found on analysis to contain about 60 per cent. of carbon, 33 per cent. of oxygen, and 6 per cent. of hydrogen. The carbon is thus present in only about two-thirds the quantity found in bituminous coal, while the oxygen is from twice to ten times the amount, the hydrogen in the two cases being about the same. Air-dried peat has, on an average, only one-half the calorific value of coal, while even when kiln-dried the proportion does not exceed two-thirds. It thus compares rather unfavorably with coal so far as heating properties are concerned, and its greater bulk and crumbliness make it less suitable for storage and transport, although these disadvantages are to some extent compensated by the fact that, being found on the surface, deep underground workings, with the heavy working costs thereby involved, are unnecessary. As a fuel it has advantages over coal in the very small amount of sulphur present, and the entire absence of slagging. Its freedom from sulphur renders the iron from peat-fed blast-furnaces equal in quality to the best charcoal iron, and the quantity of oxygen present in the substance makes a smaller air supply necessary, hence reducing the wasteful passage of nitrogen through the fuel.

"The most serious drawback to its use, however, consists in the enormous quantity of water always contained in it in its natural state. When cut from the bog, water is present to the extent ot nearly

90 per cent. by weight, and even after standing in stacks in the open air until, as far as can be seen, they are perfectly dry, the sods still retain over 25 per cent. of moisture. Furthermore, in this condition, it is very bulky and friable; and though the cost of digging and stacking it is extremely low, before peat becomes a marketable commodity other treatment, with the object of drying and consolidating it, is necessary."

On the continent various plans have been tried to remove the excess of moisture from peat, these including the use of hydraulic pressure to form it into briquettes, and also the employment of centrifugal machines to throw off the water. Neither of these processes have accomplished the desired result, the method of pressure leaving more than 60 per cent. of moisture still in the peat, and the centrifugal method being also ineffective and costly. Drying by heat has been more satisfactory, but the commercial success of this process remains to be demonstrated.

"An electrical process of drying peat has been proposed, and we understand that a plant is now being erected in Ireland for the purpose of carrying out the idea on a commercial scale. After a certain amount of water has been extracted by a centrifugal machine, electrodes are inserted in the peat mass and current from a dynamo passed through for some time. The current heats the mass on account of its resistance, and is further claimed to rupture the cellular fibrous matter, and thus assist the final consolidation. It will be very surprising if such a process can compete successfully with heating by the direct action of fuel; for whereas one unit of electricity cannot possibly develop more than 3,410 heat units, and at present requires about 3 pounds of coal to produce, the direct combustion of the same coal would develop about thirteen times the amount given back on degrading the electricity into heat.

"The peat, after being dried and disintegrated, has next to be formed into small dense briquettes. The most convenient shape for these is cylindrical, having a diameter of 2 inches to 2½ inches and of equal depth. The presses used for this purpose are of two kinds: one in which the descending ram drives a certain quantity of peat into a die with a closed bottom, and the other in which the die is in the form of an open-ended tube about 12 inches long. The latter type, known as the Dickson press, from the name of its inventor, depends for its action on the friction caused by the pressure of the briquettes on the walls of the tube. It is found that a pressure of 8 tons per square inch is required to force the column of finished briquettes along the tube against the frictional resistance only, and this is sufficient to make a dense and well-finished briquette."

Far more promising than any methods of drying the peat are those which involve the conversion of the fuel into gas for direct use in internal-combustion motors. In the gas producer the presence of the moisture in the peat is not objectionable, much less steam is required for the production of the water-gas than would be required with anthracite coal or other dry fuel, while the absence of sulphur and phosphorus renders the product especially pure. In the fuel tests of the United States Geological Survey, made in connection with the St. Louis exhibition, the marked advantages of lignite as a fuel for the gas producer were strikingly demonstrated, and similar favorable conditions exist in the case of peat. Practical experiments have shown that gas produced in the ordinary way from peat has a calorific value of about 150 British thermal units per cubic foot, this corresponding closely to Dowson gas, and being well adapted for use in gas engines, while the freedom from tarry deposits give it a marked advantage. There appears to be no good reason why peat briquettes should be satisfactorily used in the suction gas producer, and this being the case there is a wide field opened for the industrial application of the fuel.

"For the utilisation of peat on a commercial scale some more efficient way of harvesting it than the usual method of digging it by hand from the bog is essential. The means adopted will depend to a great extent on the comparative dryness and solidity of the bog. In some cases much of the water can be drained away previously to attempting to remove the peat; but if that is impossible owing to the formation of the land, a dredger, similar to those used for harbor work, is floated on the surface and delivers peat, in the form of mud, to barges in attendance. An aerial ropeway forms a convenient system of transport from the barges to *terra firma*. In the cases of fairly dry bogs the surface is cleared of growing moss, stumps of trees, etc., which will serve as fuel for the drying plant. In some of the Canadian bogs portable tramways are laid on the top of the bog to convey the peat to the works. The surface of the bog is then harrowed, and when the loosened peat has become fairly dry by the action of wind and sun, it is raked together, loaded into trucks and hauled to the briquetting works. At other bogs mechanical dredgers running of broad wheels are employed. An endless chain, fitted with alternate knives and scraping plates, works along the face of a trench about 4 feet deep. The peat sliced off is raised to the top of the machine and deposited on to a conveyor, which delivers it into a casing containing a rapidly-revolving paddle wheel. The blades of the latter drive the peat out in a continuous shower, which falls on the ground 10 or 15 yards away. The layer thus formed is about half an inch thick, and soon becomes fairly dry, when it is raked up and taken to the works."

It is thus seen that by the application of engineering methods to the utilisation of peat fuel, the great deposits existing in Ireland and elsewhere may be made available for manufacturing purposes, and it is not impossible that, in the event of a failing coal supply, other natural resources will be called upon, the peat bogs of Ireland may come to the rescue, in part, at least, of the depleted coal measures of England and Wales.

THE USE OF ELECTRICAL INSTRUMENTS.

PRACTICAL CONSIDERATIONS IN CONNECTION WITH THE HANDLING OF ELECTRICAL INSTRUMENTS IN RELATION TO THEIR ACCURACY.

H. B. Taylor—Electric Journal.

WITH the advent of electricity into the domain of practical engineering the working engineer has been put into charge of a variety of instruments of a totally different nature from those to which he was formerly accustomed. The steam engineer has his pressure gauges and water glasses, and of late he has become fairly well accustomed to the use of the indicator. When a test is to be made there will also be used a calorimeter, to determine the proportion of moisture, while water meters, thermometers, and in some cases barometers are brought into the engine and boiler room, but usually in company of an expert who uses them himself and carries them away with him.

The instruments in daily use in the electrical generating station are of a totally different kind, but at the same time all measuring appliances have fundamental principles in common, and it is very desirable that the men by whom such appliances are used should have some general ideas of their construction and the right use of them to obtain reliable results. In a paper by Mr. H. B. Taylor, in a recent issue of the *Electric Journal*, there are a number of excellent suggestions upon this subject, and an abstract of the principal points will be found of interest.

"In using electrical measuring instruments and in setting them up for making a test, there are certain points to be considered which are likely to be overlooked by men who have not frequent occasion to use them. This is especially true where a number of instruments are to be used on one test. In the effort to put all the instruments in places where they can be conveniently read and at the same time have other apparatus within easy reach, there are many chances of placing some of the instruments in locations where their calibration will be temporarily affected by their influence upon each other or by the effect of some other piece of apparatus or part of the conducting circuit.

"A knowledge of the principle upon which an instrument operates, the location of its winding and of its magnet, if any, should enable the person using it to judge whether a particular location is suitable. Some instruments are quite susceptible to external influences, while with others, scarcely any attention need be paid to the location of stray magnetic fields. So many kinds of instruments are in use that it would not be possible in a short article to discuss the different types, or the various capacities of those of any particular type, but it may be said in general that there are more opportunities for error in measuring heavy currents than in measuring small ones. In direct current work there may be disturbing influences entirely apart from the apparatus in use on the test; such, for instance, as the field of a motor or a generator or a nearby bus-bar carrying heavy currents. Instruments containing permanent magnets will, if placed too close together, influence each other. The natural tendency is to place them in almost the worst possible position; that is, side by side. A space of from two to three feet may be taken as a safe distance to allow between direct current meters of the ordinary portable type. When space is very limited, two instruments can often be brought closer together without causing trouble, by placing one of them with its scale inverted with respect to the other, so that the neutral parts of the magnets are nearest to each other and the pole pieces as far apart as possible. For the most accurate results even the earth's magnetic field must be taken into account, the maximum possible variation in reading from this cause being usually a little more than one-tenth of one per cent."

It is a well known principle in using many kinds of instruments to employ the principle of reversal, just as a draftsman tests the correctness of a triangle by drawing a perpendicular and then turning the triangle over to see if the two lines coincide. In like manner Mr. Taylor advises that electro-magnetic instruments designed for use on both alternating and continuous currents should be read with the current first in one direction and then in the other when employed with direct currents. If the readings do not agree, their mean will be the correct reading.

In the case of alternating and direct current instruments designed for heavy currents, especial care must be taken in bringing in the lead. Such instruments usually have only a turn or two in the coils carrying the main currents, and if the wires bringing the current to them form a loop a disturbing magnetic field will be created.

Mr. Taylor discusses the various methods of determining the corrections for instrumental errors, and although such corrections should be furnished by the maker of the instrument it is desirable to be able to verify the factors or to find them if they have not been given.

"Modern electrical instruments will stand a great deal of service under severe conditions if proper care and judgment are exercised in handling them. They will even stand a certain amount of ill treatment that would seldom be met with except through carelessness. Experience shows, nevertheless, that there are few instruments in daily service which do not occasionally meet with more or less damage. In nearly all instances where a meter is overheated, broken, or otherwise thrown out of adjustment, the cause of trouble is quite apparent as soon as the damage is done, and the person responsible finds that he knew beforehand what would happen under the conditions which caused the trouble, but had failed to notice that these conditions existed. When a man connects an ammeter in shunt across a 500-volt circuit it is seldom because he thought that the proper way, but because he thought he had a resistance, or something having the same effect, in series. To have mentioned to him a week previously that ammeters should not be connected that way would probably not have prevented the accident. It is therefore not easy to compile a useful list of connections to be avoided."

No satisfactory method appears to have been devised for protecting voltmeters against sudden overloading, and the best plan for avoiding injury is to keep them disconnected at all times when readings are not being taken. Fuses will prevent the windings from being actually burned out, but they cannot prevent the mechanical injuries due to sudden overload shocks.

"The question of zero errors and how to correct for them is of frequent occurrence. Sooner or later the index of nearly every meter fails to indicate zero at zero load. The exact reason is not always apparent. It may be known that the error appeared immediately after a short circuit or after the meter was dropped to the floor, but that information would not show whether the spring had changed its shape, the index bent, some part of the movement slipped or one or more of a number of other possible disarrangements had happened. A rather common source of error at zero as well as at other readings is a fine springy piece of lint resting on a fixed part and pressing lightly against the movable part in such a way as not to cause friction, but acting as a little additional spring.

"To add, algebraically, the zero error to the observed reading seldom gives exactly correct results. Sometimes it introduces a greater error than if no correction had been attempted."

Scale corrections are necessary in nearly all kinds of graduated instruments if the highest degree of accuracy is required, and in general no uniform law is found to govern the variations in different parts of the scale. In ordinary daily service such a high degree of precision is generally not required, but when the best results are demanded, as in careful scientific testing, the errors of all parts of the scale should be tabulated, as is the case with first-class thermometers or barometers, and the necessary correction can then be applied before any computations have been made.

ENGINEERING AND IRRIGATION.

THE WORK OF THE ENGINEER IN THE REGULATION AND CONTROL OF WATER SUPPLY FOR IRRIGATION PURPOSES.

British Association for the Advancement of Science.

THE visit of the British Association for the Advancement of Science to South Africa is a matter of general interest, while among the various papers there are several appealing to the engineer because of their special applicability to different departments of applied science. Among these we note the presidential address to the engineering section, by Colonel Sir C. Scott Moncrieff, dealing especially wth irrigation problems and their solutions in various parts of the world.

After briefly referring to primitive methods of distributing water over arid portions of land, Col. Moncrieff proceeds to discuss the subject from the viewpoint of the modern engineer.

"Irrigation on a large scale is best effected by diverting water from a river or lake into an artificial channel, and thence on to the fields. If the water surface of a river has a slope of 2 feet per mile, and a canal be drawn from it with a surface slope of 1 foot per mile, it is evident that at the end of a mile the water in the canal will be 1 foot higher than that in the river; and if the water in the river is 10 feet below the plain, at the end of 10 miles the water in the canal will be flush with the plain, and henceforth irrigation can be effected by simple gravitation. When there is no question of fertilizing deposit, and only pure water is to be had, the most favorable condition of irrigation is where the canal or the river has its source of supply in a great lake. For, be the rainfall ever so heavy, the water surface in the lake will not rise very much, nor will it greatly sink at the end of a long drought. Where there is no moderating lake, a river fed from a glacier has a precious source of supply. The hotter the weather, the more rapidly will the ice melt, and this is just when irrigation is most wanted. Elsewhere, if crops are to be raised and the rain cannot be counted on nor well irrigation be practised, water storage becomes necessary, and it is with the help of water storage that in most countries irrigation is carried on.

"To one who has not given the subject attention surprise is often expressed at the large volume of water that has to be stored to water an acre of land. In the case of rice irrigation in India it is found that the storage of a million cubic feet does not suffice for more than from six to eight acres. For the irrigation of wheat about one-third this quantity is enough. It would never pay to excavate on a level plain a hollow large enough to hold a million cubic feet of water. It is invariably done by throwing a dam across the bed of a river or a valley and ponding up the water behind it. Many points have here to be considered—the length of dam necessary, its height, the material of which it is to be constructed, the area and the value of the land that must be submerged, the area of the land that may be watered. The limits of the height of a dam are from about 150 feet to 15 feet. If the slope of the valley is great, it may be that the volume which can be ponded up with a dam of even 150 feet is inconsiderable, and the cost may be prohibitory. On the other hand, if the country is very flat, it may be that a dam of only 20 feet high may require to be of quite an inordinate length, and compensation for the area of land to be submerged may become a very large item in the estimate. I have known of districts so flat that in order to irrigate an acre more than an acre must be drowned. This looks ridiculous, but is not really so, for the yield of an irrigated acre may be eight or ten times that of an unirrigated one; and after the storage reservoir has been emptied it is often possible to raise a good crop on a saturated bed.

"The advantage of a deep reservoir is, however, very great, for the evaporation is in proportion to the area of the surface, and if two reservoirs contain the same volume of water, and the depth of one is double that of the other, the loss by evaporation from the shallow one will be double that of the deep one. In India, from time immemorial, it has been the practice to store water for irrigation, and there are many thousands of reservoirs, from the great artificial lakes holding as much as 5,000 or 6,000 millions of cubic feet, down to the humble village tank holding not a million. There are few of which the dam exceeds 80 feet in height, and such are nearly always built of masonry or concrete. For these it is absolutely necessary to have sound rock foundations. If the dam is to be of earth the quality of the soil must be carefully seen to, and there should be a central core of puddle resting on rock and rising to the maximum height of water surface. If the dam is of masonry there may perhaps be no harm done should the water spill over the top. If it is of earth, this must never happen, and a waste weir must be provided, if possible cut out of rock or built of the best masonry, and large enough to discharge the greatest possible flood. More accidents occur to reservoirs through the want of sufficient waste weirs or their faulty construction than from any other cause.

"As important as the waste weir are the outlet sluices through which the water is conveyed for the irrigation of the fields. If possible they should be arranged to serve at the same time as scouring sluices to carry off the deposit that accumulates at the bottom of the reservoir. For, unless provided with very powerful scouring sluices, sooner or later the bed of the reservoir will become silted up, and the space available for water storage will keep diminishing. As this happens in India, it is usual to go on raising the embankment—for it does not pay to dig out the deposit, and so the life of a reservoir may be prolonged for many years. Ultimately it is abandoned, as it is cheaper to make a new reservoir than to dig out the old one."

Col. Moncrieff refers briefly to the irrigation systems of Italy, India, Egypt and America, all of these countries showing the large return in value derived from the introduction of irrigation works upon regions otherwise of small value. Thus the total cost of the Assouan dam, the Assiout barrage, and the canal work connected with the improvements which have been made in Egypt, is given as about £6,500,000, while the rental value of the land has been increased by £2,637,000 and the sale value by £26,570,000.

"It is evident that there are many serious considerations to be taken into account before entering on any large project for irrigation. Statistics must be carefully collected of rainfall, of the source of water supply available, and of the amount of that rainfall which it is possible to store and utilize. The water should be analyzed if there is any danger of its being brackish. Its temperature should be ascertained. It should be considered what will be the effect of pouring water on the soil, for it is not always an unmixed benefit. A dry climate may be changed into a moist, and fever and ague may follow. In India there are large tracts of heavy black soil, which with the ordinary rainfall produce excellent crops nine years out of ten, and where irrigation would rather do harm than good. But in the tenth year the rains fail, and without artificial irrigation the soil will yield nothing. So terrible may be the misery caused by that tenth year of drought that even then it might pay a government to enter on a scheme of irrigation. But it is evident that it might not pay a joint stock company. In all cases it is of the first importance to establish by law the principle that all rivers or streams above a certain size are national property, to be utilized for the good of the nation. Even where there is no immediate intention of constructing irrigation works, it is well to establish this principle. Otherwise, vested rights may be allowed to spring up, which it may be necessary in after years to buy out at a heavy cost."

The large extent of modern irrigation works and the complex industrial conditions by which they are surrounded raises them above the level of ordinary commercial undertakings and places them on a plane which demands that they shall be placed under government control. In Italy important works were originally undertaken by private enterprise, but these were subsequently taken over by the government, upon the failure of the original syndicate to conduct them successfully. In the United States there are great reclamation undertakings now being executed by the national government, and in general it seems to be conceded that such plans are too closely connected with the general welfare of a country to be governed by strict commercial considerations, but fall rather into the category of the control of navigation, or the transmission of intelligence.

STORES KEEPING IN RAILWAY WORK.

PRACTICAL METHODS OF ORGANIZING AND OPERATING THE STORES-KEEPING DEPARTMENT OF A RAILWAY SYSTEM.

C. F. Balch—Railway Age.

IN the complete organization of a works management system the stores department necessarily occupies an important position, and there have already been published among the leading articles in this magazine papers discussing the subject as developed in various manufacturing establishments. In a recent issue of the *Railway Age* we note a paper by Mr. C. F. Balch, giving the results of practical experience under the peculiar conditions involved in railroad service, and some of the points brought out will be found of interest, both to railroad men and other managers of industrial establishments.

"The importance of the store department is very often underrated and its claims made secondary to those of the other operating departments, but it is a fact that the store department of a railroad is as necessary to its successful operation as the commissary department of an army is to a successful military campaign, and the development of the store department to the highest degree of efficiency, as a means of economizing the use of material, should be the earnest desire of every operating official.

"The requirements of railway service are more and more exacting, as the systematic movement of traffic made necessary by severe competition demands each year an increasing degree of excellence in all departments, in order that nothing shall prevent the correct working of every branch of the service which makes a successful general result possible. This touches the store department in the measure that it requires a degree of promptness in delivering material where needed, which makes it necessary to anticipate every requirement and thus avoid the possibility of the service being in any measure impaired or injured by the lack of material; especially is this true with regard to repairs of rolling stock, for during busy periods, when it is absolutely necessary to utilize every possible resource, any delay for lack of material will cost possibly several times the value of the material required, in the loss of traffic, and produce a result which cannot be definitely known but which is to be deplored, and the more so as it is possible to avoid it. This particular feature of the store department is very important, and has been of that conspicuousness that it has been largely the cause of the store department being in many cases made subordinate to the mechanical department, either from choice, or from the fact that from the lack of desire on the part of any other department to assume the responsibility of these very contingencies, when it was possible to avoid so doing, the responsibility naturally gravitates to the mechanical department, and so the store department has found its lodging in the arms of the mechanical department. It follows that the organizing of a store department as a separate department is a decided relief to the mechanical department, and very much to its advantage."

Mr. Balch divides the stores department problem into the distinct lines of facilities, organization, and operation. Broadly the arrangement of stores keeping facilities may well be based upon the department store idea, the contents being arranged in groups so that each department may receive its proportional degree of attention.

So far as the organization is concerned, Mr. Balch emphasizes the importance of making adequate provision for a sufficient physical force to handle the material promptly, and an ample clerical force to check and record the movement of the stock and to have it fully and properly accounted for.

"The correct operation of the store department should result in the prompt, precise procuring of material from the manufacturers, and delivery at the point on the line where required for service. A few suggestions only in this line are herein stated.

"There should be a generally simple and concise method of diffusing information through the department, examples of which are as follows:

"A well compiled list of castings is essential, giving pattern number and information concerning each pattern, in handy form well bound, and in such shape that every car repairer, shop foreman or other official ordering material from the store department may give the correct description of articles desired.

"The value of material should be emphasized to everyone using it. For example, have the prices printed opposite the name of each item on the form on which each section foreman makes his monthly report of tools and material on hand, thus bringing before him the exact meaning in a money way of the materials in his charge.

"A careful estimate of materials on hand each month must be made, and record of the same in such a way as to form statistics from which future needs may be anticipated. Examples of this are in stock books, the stock card, card systems of requisitions, stock sheets, etc., which systems have varying values under different conditions, and are more or less practical as they are carefully manipulated or otherwise.

"At large points, where it is necessary for papers to pass through many hands for approval and then several hands at the storehouse before the final action of loading occurs, it is necessary that all papers be quickly understood, and that descriptions be explicit to avoid both errors in the conception of the order by approving officials, as well as errors in the shipment of the material.

"Prompt movement of all papers connected with the disbursements of materials is most important. If a request for a bill of material lies on the desk of an approving official for one week it is as detrimental to the prompt delivery of that material as though the material was loaded in a car and stood on a sidetrack for an equal length of time. The latter would quite likely be severely criticized by that same official, who would hold the papers a week for signature.

"The use or application of material to the service is quite another subject, and its particular bearing in this connection is that where the store department is lacking in efficiency, it has a tendency to thwart the efforts of the management in instituting economical practices.

"The object of it all is to have what you want, where you want it, when you need it, and any failure to accomplish this causes the substitution of something else, either not so suitable, or more expensive, or in other ways not so well adapted to the service as the correct material."

THE ENGINEERING INDEX

THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

The New Masonry Arch Bridge at Plauen, Saxony, and two bridges in the Black Forest. W. J. Douglas. Illustrates and describes three interesting masonry arches. 2500 w. Eng News—Aug. 17, 1905. No. 71378.

Accident.

The accident to the Maximilian Bridge at Munich (L'Accident du Pont Maximilien à Munich). Describing the slipping and displacement of one of the hinges of an arch, with computation of the magnitude and direction of the forces causing this action. 1800 w. Génie Civil —July 22, 1905. No. 71516 D.

Cantilever.

Cantilever Bridge Across the River Mattig, Austria. Gives skeleton elevation and plan of a three-span cantilever bridge recently erected, with description from

Le Génie Civil. 600 w. Eng, Lond—July 28, 1905. No. 71259 A.

Cantilever Bridge over the Mississippi River. Begins an illustrated detailed description of the Thebes Bridge. 1600 w. Eng, Lond—July 21, 1905. Serial. 1st part. No. 71169 A.

Floors.

Protecting and Water—Proofing Solid Floor Bridges. W. C. Cushing. Reprinted from Bul. 64 of the Am. and Main. of Way Assn. An illustrated explanation of some of the plans used on the P., C., C. & St. L. at Brighton Park and Engelwood, in 1904. 5500 w. R R Gaz—Vol. XXXIX., No. 5. No. 71224.

Foundations.

Compressed Air Foundations for Bridges. G. W. M. Boycott. An illustrated article dealing with pneumatic cylinders and caissons only, and giving brief descriptions of work in England. 2800 w. Eng, Lond—Aug. 4, 1905. Serial. 1st part. No. 71367 A.

Loads.

Maximum Bending Moments Due to Rolling Loads. An investigation of the stresses produced by loads rolling over bridges. Explains method of obtaining the greatest stress for two, three and four loads, and general conclusions for all loads. 2000 w. Eng, Lond—July 21, 1905. No. 71168 A.

Manhattan.

The Superstructure of the Manhattan Bridge, New York. An illustrated general description of the third East River Suspension Bridge. 2800 w. Eng Rec—July 29, 1905. No. 71125.

Plate-Girder.

The erection of the Great Tonoloway Creek Bridge. Illustrates and describes the erection of a deck bridge having three single-track plate-girder skew spans, on a sub-structure built to receive two additional lines of girders when the road is double-tracked. 1600 w. Eng Rec—July 29, 1905. No. 71131.

Rail-Bearers.

The Deflection of Continuous Rail-Bearers. Max am Ende. Begins a mathematical discussion of rail-bearers having a uniform support. Continuous rail-bearers are used in railway bridges for the distribution of pressure from a rolling load upon several cross-girders. 1700 w. Engng—July 21, 1905. Serial. 1st part. No. 71160 A.

Reconstruction.

Replacing a Four-Track Bridge Under Heavy Traffic. Brief account of methods adopted in replacing an old structure by a new one without interrupting traffic. The bridge carries the N. Y. C. & H. R. R. R. over the Erie canal near Newark, N. Y. Ills. 1000 w. Eng Rec—July 29, 1905. No. 71128.

Reinforced Concrete.

Reinforced Concrete Bridges in a Newark Park. Illustrated description of two single-arch bridges of monumental design, in Branch Brook Park, with the methods of construction. 2500 w. Eng Rec—Aug. 12, 1905. No. 71330.

The Kazarguene Bridge. Illustrates and describes a bridge 985 feet long, built of reinforced concrete. The methods of construction, and the materials are discussed. 1700 w. Sci Am Sup—Aug. 12, 1905. No. 71283.

Suspension.

The Chain Suspension Bridge at Budapest, Hungary. An illustrated account of a large bridge of unusual construction, describing the methods of erection and features of interest. 4500 w. Eng News—Aug. 24, 1905. No. 71477.

Wire Cables and Wide Cable Spans (Drahtseile und Grosse Seilspannweiten). Sigfried Abt. Describing improved methods of laying wire cables, together with data about wide suspension spans. 2000 w. Schweiz Bauzeitung—July 15, 1905. No. 71588 B.

Treskow.

The Treskow Bridge at Oberschöneweide near Berlin (Die Treskow-Brücke zu Oberschöneweide bei Berlin). Karl Bernhard. A very full account of the new bridge over the Spree, with full details of construction. The main span is 226 feet. Three articles. 9000 w. Zeitschr d Ver Deutscher Ing—July 15, 29, Aug. 5. No. 71503 each D.

Viaducts.

The Erection of the Bellevue Viaduct. Illustrated description of a viaduct, near Pittsburg, which will carry a double-track electric railway, highway traffic, and six sidewalks. 1000 w. Eng Rec—Aug. 26, 1905. No. 71620.

The Erection of the James River Viaduct, Richmond, Va. Illustrated description of the design and construction. 1200 w. Eng Rec—Aug. 5, 1905. No. 71241.

Washington, D. C.

The Anacostia Bridge, Washington, D. C. An illustrated description of an unusually interesting structure, 1000 feet long, consisting of six arches and one drawspan. 1500 w. Ry Age—Aug. 11, 1905. No. 71301.

The Anacostia Bridge, Washington. Begins an illustrated detailed description of the steel arch deck structure across the Potomac River, under construction by the U. S. government. 2500 w. Eng Rec—Aug. 19, 1905. Serial. 1st part. No. 71440.

CONSTRUCTION.

Beams.

The Theory of Laterally Curved Beams (Zur Theorie der Seitlich Gekrümmten Träger). A mathematical study of the forces acting upon curved beams such as are employed in balconies and similar structures. 2500 w. Deutsche Bauzeitung—July 26, 1905. No. 71590 B.

Blast.

Destruction of Henderson's Point. Charles B. Morse. An illustrated description of the methods used in removing this rocky point at Kittery, Maine, made necessary in the widening of the channel of the Piscataqua River, so that large warships might reach the new drydock. 1400 w. Compressed Air—Aug. 1905. No. 71471.

The Great Blast at Henderson's Point, Portsmouth Navy Yard. Illustrates and describes the explosion of 38 tons of dynamite, in a submarine blast. The method used was of unusual interest. 1400 w. Eng News—Aug. 3, 1905. No. 71175.

Buckling.

A Simple Demonstration of the Principles of Buckling Action (Eine Einfache Vorrichtung zur Veranschaulichung des Knickungsvorganges). A. Summerfeld. Describing an experimental method by observing the vibrations of a rod fastened at one end and adjustable as to length. 2500 w. Zeitschr d Ver Deutschef Ing—Aug. 12, 1905. No. 71512 D.

Building Construction.

The Erection of the Wanamaker Building, Philadelphia. Illustration, with brief description of methods of construction. 1800 w. Eng Rec—Aug. 5, 1905. No. 71243.

Contractor's Plant.

Electric Installation for Contractor's Plant on Brooklyn Anchorage of Manhattan Bridge. Describes the electric plant for the use of power instead of hand labor whenever possible. Electric apparatus is used for pile-driving, hoisting, traction, concrete mixing, pumping and lighting. 1500 w. Ills. Eng Rec—Aug. 26, 1905. No. 71622.

Dams.

Investigation of Stresses in High Masonry Dams of Short Spans. George Y. Wisner and Edgar T. Wheeler. A report made to F. H. Newall, Chief Engineer of the U. S. Reclamation Service. Gives a general discussion by Mr. Wisner and Mr. Wheeler's analysis of stresses in the proposed Pathfinder Dam, Wyoming. 4000 w. Eng News—Aug. 10, 1905. No. 71276.

On the Stability of Masonry Dams. Karl Pearson. A reply to Mr. Dilley's criticisms of an earlier article on this subject. 2200 w. Engng—Aug. 11, 1905. No. 71460 A.

Stresses in Dams. J. S. Wilson and W. Gore. Gives an experimental method of investigating the distribution of stress in dams, cet. Ills. 1800 w. Engng—Aug. 4, 1905. No. 71359 A.

Dam.

The Wachusett Dam of the Metropolitan Water Works. George W. Blodgett. Illustrates and describes some of the principal features of the design of this great masonry dam, and the methods of construction. Also editorial. 4000 w. R R Gaz—Vol. XXXIX. No. 5. No. 71223.

Docks.

New Dock at Manchester. An illustrated article describing the interesting features. 1200 w. Engr, Lond—July 28, 1905. No. 71258 A.

Filling.

The Handling of Material for Filling Grant Park, Chicago. Illustrated description of the interesting dumping equipment used for this work. 1200 w. Eng News—Aug. 24, 1905. No. 71479.

Foundations.

Chicago Foundations. E. C. Shankland, in the *Technograph*. Explains the character of the soil and the troubles causing the great settlement of buildings, describing the kind of foundation now used. 2700 w. Eng Rec—July 29, 1905. No. 71130.

See Civil Engineering, Bridges.

Lighthouse.

Building the Beachy Head Lighthouse. Notes from a paper by Albert H. Case, submitted to the Inst. of Civ. Engrs., describing and illustrating the methods used in erecting this new lighthouse. 3700 w. Eng Rec—July 29, 1905. No. 71126.

Retaining Walls.

Concerning Retaining Walls and Earth Pressures. H. P. Boardman. Discusses the principal retaining wall theories and their defects, and considers their strength and stability, and suggests the making of experimental tests on a large scale to obtain data concerning the lateral pressure of earth. 5500 w. Eng News—Aug. 17, 1905. No. 71380.

Roofs.

Machine Shop Roofs. John E. Sweet. A short article, with sketches, giving suggestions for the design of roofs. 600 w. Cassier's Mag—Aug., 1905. No. 71386 B.

Steel Framework.

Steel Work of the New General Electric Machine Shop. Begins an illustrated detailed description of this building at Schenectady which represents the best construction and latest features for buildings of its class. 1300 w. Eng Rec—Aug. 12, 1905. Serial. 1st part. No. 71322.

Tunnels.

Construction of the Pocahontas Tunnel, New York Central R. R. Illustrates and describes improvements on the Harlem Division of this road, near New York City, giving details of construction work. 1700 w. Eng Rec—Aug. 26, 1905. No. 71623.

Reinforced Concrete Passenger Tunnel—C. R. R. of N. J. Illustrations showing the plans of a subway which this railroad is now building under its main line at Netherwood, N. J. Description. 600 w. R R Gaz—Vol. XXXIX. No. 6. No. 71311.

The Barrientos Tunnel, Mexico. C. Gordon Paterson. Brief illustrated description of this tunnel and the methods of construction. 900 w. Eng News—Aug. 10, 1905. No. 71275.

The New Jersey Tunnels and Subways. Map, with explanation and description, showing the connections of Manhattan Island and the mainland by tunnels, including also the East River tunnels. 1600 w. Sci Am—Aug. 12, 1905. No. 71281.

The Telephone Tunnels in Chicago. Information of interest taken from the report of the Commissioners appointed to study these tunnels, giving the history of the undertaking, and the effect on the streets and buildings. 2000 w. Eng Rec—Aug. 26, 1905. No. 71621.

Tubular Tunnels in Water Bearing Soil (Les Tunnels Tubulaires en Terrains Aquifères). C. Birault. An account of the tunnels under the Seine for the new lines of the Paris Metropolitain. 15000 w. 2 plates. Mem. Soc. Ing. Civ. de France—June, 1905. No. 71596 G.

Tunnel Construction and the Subsidence of Streets in Chicago. Gives particulars from the report of a commission of engineers appointed to investigate the matter, showing the construction work and the relation to street settlements, attributing the trouble to excavation without the use of air pressure. 3500 w. Eng News—Aug. 24, 1905. No. 71481.

Ventilating Plants for the Construction of Large Alpine Tunnels (Die Luftungsanlagen beim Baue der Grossen Alpentunnels). Karl Brabbée. A review of experience in the ventilation of tunnels during construction; with special reference to the Bosruck, Tauern, Karawanka, and Wochein tunnels. Serial. Part I. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 11, 1905. No. 71538 D.

MATERIALS OF CONSTRUCTION.

Cement.

The Proportions of Cement Mixtures. S. B. Newberry. Explains the chemical calculations used in controlling Portland cement raw mixtures. 3000 w. Cement Age—July, 1905. No. 71318.

The Works of the Kansas Portland Cement Co. Ellis Soper. Illustrated description of the plant and its operation. 2000 w. Eng Rec—Aug. 12, 1905. No. 71329.

Cement Kilns.

The Heat Balance of the Rotary Cement Kiln (Die Wärmebilanz des Zement-Drehofens). Carl Naske. An examination of the performance of various American cement kilns, deducing a heat balance. The conclusions of Richards are criticised. 3500 w. Zeitschr d Ver Deutscher Ing—Aug. 19, 1905. No. 71587 D.

Concrete.

An interpretation of Recent Tests on the Fire Resistance of Concrete. Examines the tests made by Prof. Ira H. Woolson, and tests made by the committee of the National Fire Protection Association. 2500 w. Eng News—Aug. 24, 1905. No. 71480.

Another Use for Cement Concrete. Illustrates and describes a method of making a cheap and efficient system of ducts for underground cables. 900 w. Cement Age—Aug., 1905. No. 71497.

Curing Concrete Blocks. H. H. Rice. Discusses some points of importance in securing strength in these blocks, with remarks on their value as a building material. 1000 w. Ing Rec—July 29, 1905. No. 71129.

Tests to determine the Fire Resistance and Heat Conductivity of Concrete. Abstract of a special committee report presented at the meeting of the Nat. Fire Protection Association. Describes tests based on the theory that the fire resistance depends on the ability to withstand cracking and its heat insulating value. 2000 w. Eng News—Aug. 3, 1905. No. 71177.

Reinforced Concrete.

Concrete and Concrete-Steel in Holland. J. J. L. Bourdrer. Reviews the progress made in the use of this material in Holland, considering new uses to which it has been applied, important works completed and under construction. Ills. 5000 w. Cement Age—July 1, 1905. No. 71319.

Reinforced Concrete. Begins an illustrated description of the most important and fundamental systems. 1500 w. Sci Am Sup—Aug. 26, 1905. Serial. 1st part. No. 71487.

See also Civil Engineering, Bridges.

Sewer Pipe.

Causes of Body Crazing in Sewer Pipe. Walter A. Hull. Abstract of a paper read before the Am. Ceramic Assn. Describes the clay used in the factory where the observations were made, and the trouble with body-crazing, giving a study of the causes and the preventive measures. 3800 w. Eng Rec—Aug. 19, 1905. No. 71443.

MEASUREMENT.

Topography.

Outline of Work of the Topographic Branch of the United States Geological Survey, with details of secondary (Plane Table) Triangulation. Joseph A. Close. Ills. Explains methods used in making a surface map of the country. 12600 w. Sch of Mines Qr—July, 1905. No. 71296 D.

MUNICIPAL.

Dust Prevention.

The Oiling of Highways (Ueber Oelbesprengung von Strassen). F. Drobny. Describing the experiments made with oil sprinkling to prevent the raising of dust in the streets of Carlsbad. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 4, 1905. No. 71537 D.

London Traffic.

Report of the Royal Commission on London Traffic. Extracts from the report of commissioners appointed to inquire into the means of locomotion and transport in London. Also editorial. 15200 w. Elect'n, Lond—July 21, 1905. No. 71158 A.

Municipal Work.

Recent Municipal Work in Philadelphia. From the report of George S. Webster. Briefly considers improved sanitation, parks and parkways, laboratory work, etc. Ills. 2200 w. Eng Rec—Aug. 19, 1905. No. 71444.

Pavements.

Some Unusual Experience With Asphalt Pavements. Describes the pavement of Clinton street, Brooklyn, where three distinct pavement were laid in successive layers. A new asphalt pavement is now being laid. 1000 w. Eng Rec—Aug. 5, 1905. No. 71240.

Sewage.

An Often Neglected Factor in Sewage Analysis. Ellen H. Richards. On the importance of time where life is concerned in the change. Gives reports of tests made. 700 w. Tech Qr—June, 1905. No. 71145 E.

A Winter Visit to Some Sewage Disposal Plants in Ohio, Wisconsin, and Illinois. C. E. A. Winslow. Report on what was seen at about a dozen plants under the most unfavorable conditions of operation. Discloses inefficiency in the winter operation of many of the plants. General discussions. Ills. 11000 w. Jour Ass'n of Engng Socs—June, 1905. No. 71407 C.

Concerning Sewage Disposal from the Standpoint of Pollution of Oysters and Other Shellfish, and Especially with Reference to Their Transmission of Typhoid Fever. George W. Fuller. A concise summary of the most prominent instances of epidemics of typhoid fever and other diseases due to polluted oysters and other shellfish. Suggestions for correcting this danger. Discussions. 16000 w. Jour Fr Inst—Aug., 1905. No. 71293 D.

On the Sterilization of Effluents. Samuel Rideal. A discussion of this subject with special reference to oysters and other shellfish, and to watercress beds. Also discussion. 17600 w. Jour Roy San Inst—Aug., 1905. No. 71313 D.

Sewage Purification with Special Reference to the Problem in Ohio. R. Winthrop Pratt. Gives a brief account of the general history and theory of sewage purification, and states the geological conditions in Ohio which affect this problem, describing some of the principal Ohio plants. Ills. 10500 w. Jour Ass'n of Engng Socs—June, 1905. No. 71406 C.

The Treatment of Crude Sewage in Triple Contact-Beds. T. Hughes. From a paper before the British Ass'n of Mgrs. of Sewage Disposal Works. Gives the results of six years endeavor to deal with crude sewage in "bacteria" or "contact-beds" without any preliminary treatment or separation. 5400 w. Mining Engng—Aug., 1905. No. 71287 C.

Sewers.

Difficulties of Construction in an Outlet Sewer. From a report by Alexander Potter; concerning the unusual difficulties encountered in the construction of the joint outlet sewer of Essex and Union counties, New Jersey. 4000 w. Eng Rec—Aug. 19,1905. No. 71439.

Some Specialties of the System for Flushing the New Sewers of the City of Mexico. Roberto Gayol. Detailed description of sewers and sewerage system, with many illustrations and plans. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1905. No. 71645 E.

The Walworth Sewer, Cleveland, Ohio. Walter Camp Parmley. Complete description, very fully illustrated, of the largest sewer in Cleveland. 20000 w. Pro Am Soc of Civ Engrs—Aug., 1905. No. 71646 E.

The Use of Concrete in Sewer Construction. W. C. Parmley. States the advantages of concrete sewers over brick masonry, and gives notes and observations of personal experience in the construction of concrete sewers. Illustrations and general discussion. 12000 w. Jour Ass'n of Engng Socs—June, 1905. No. 71405 C.

Smoke Prevention.

The Smoke Nuisance and its Abatement (Die Rauchplage und Ihre Bekämpfung). Eduard Meter. A general discussion of the smoke problem in Vienna. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—July 21, 1905. No. 71536 D.

WATER SUPPLY.

Cincinnati, O.

Progress of Work on the New Water Supply System of Cincinnati, O. Reviews the present conditions of the different parts of the system. Ills. 2500 w. Eng News—Aug. 24, 1905. No. 71478.

Filtration.

Mechanical Filters of the Brooklyn, N. Y., Water Works. Illustrates and describes two mechanical filter plants, built to purify a small portion of the water supply, which have given uniformly good results since completed, about two years ago. 3000 w. Eng Rec—Aug. 26, 1905. No. 71619.

The Employment of Restraining Culture media in testing the hygienic Efficiency of Sand Water Filters. A. Robin. Remarks on the defects of methods employed for testing filters, giving tabulated results, and discusses the employment of restraining media for determining the hygienic efficiency, especially bile and salt agar, and the results. 4500 w. Eng News—Aug. 17, 1905. No. 71379.

Ground Water.

The Movement of Ground Water (Over de Beweging van Grondwater). J. M. K. Pennink. Describing interesting experiments with artificial sand beds, reproducing natural conditions of subterranean water flow. 3500 w. De Ingenieur —July 29, 1905. No. 71589 D.

Lick Observatory.

An Example of the Legitimate Use of Water for Domestic Purposes. K. F. Cooper. Facts and figures showing the economical and yet ample use of water at the settlement at Lick Observatory, California. 1000 w. Pro Am Soc of Civ Engrs—Aug., 1905. No. 71647 E.

Pipe Corrosion.

Electrolysis on the Metropolitan Water Works. Extracts from the report of F. P. Stearns for the last year, giving results of tests made and conditions found when the annual survey was made to determine the corrosion due to the electrolytic action of stray currents. 1600 w. Eng Rec —July 29, 1905. No. 71127.

Pressure.

Pressure in City Water Works from Fire Protection View-point. Abstract of the report of E. G. Hopson. Urges the extended use of sprinkler equipments, effective interior standpipe services, and discusses the value of higher pressures for fire protection and the objections. 4000 w. Eng Rec—Aug. 19, 1905. No. 71442.

Pumping Engine.

See Mechanical Engineering, Hydraulics.

Rates.

The Principles Governing the Valuation for Rate Fixing Purposes of Water Works Under Private Ownership. Arthur L. Adams. Read before the Pacific Coast Engng. Cong. Considers the various factors likely to influence the value of any property, discussing their degrees of importance. 8000 w. Eng Rec—Aug. 5, 1905. No. 71242.

River Water.

Tastes and Odors in River Water Supplies. Information collected by Mr. Dow R. Gwinn, showing that the evil is widespread. 1500 w. Eng News—Aug. 3, 1905. No. 71178.

WATERWAYS AND HARBORS.

Buenos Ayres.

The Port of Buenos Ayres (Le Port de Buenos Aires). Auguste Moreau. A review of the Huergo project for the improvement of the harbor at Madero. 5000 w. 1 plate. Mem Soc Ing Civ de France—April, 1905. No. 71595 G.

Canal Lift.

The Electric Portion of a Canal Lift System (Der Elektrische Teil der Weltbewerbsarbeiten für ein Kanal Schiffshebewerk). Ernst Kronstein. A description of the electrical portion of an inclined-plane canal lift proposed for the Danube—Oder canal scheme. 4000 w. Zeitschr f Elektrotechnik—July 30, 1905. No. 71574 D.

Canals.

Canada's Canal System. M. M. Wilner. An illustrated account of the canals along the St. Lawrence river, around Niagara Falls, and connecting the Great

Lakes. 3500 w. Rev of Revs—Aug., 1905. No. 71121 C.

Canal Transport. Discusses the canals of Great Britain, their improvement, and the method of haulage, their cost, etc., especially illustrating and describing the method of electric traction employed on the Teltow Canal. Also editorial. 4000 w. Ir and Coal Trds Rev—Aug. 4, 1905. No. 71341 A.

Sault Canal Celebration. An account of the celebration of the fiftieth anniversary, with the historical address of Hon. Peter White. Ills. 8000 w. Marine Rev—Aug. 3, 1905. No. 71208.

Sault Canal Celebration. An illustrated article giving particulars of the exercises and the addresses of Gov. Fred M. Warner and Vice-President Fairbanks, and extracts from other addresses. 6000 w. Marine Rev—Aug. 10, 1905. No. 71310.

The Actual Problems of the Panama Canal. John F. Wallace. The first of a series of critical articles discussing the plans and methods of execution of the works at the isthmus. 4500 w. Engineering Magazine—September, 1905. No. 71654 B.

The Improvement of the Ohio Canals. W. Frank McClure. A brief account of improvements to create a new deep water link between Lake Erie and the Ohio River, with illustration of the weigh-lock of the Ohio and Erie canal. 900 w. Sci Am—Aug. 5, 1905. No. 71184.

The Semi-centennial of St. Mary's Falls Canal. An illustrated article briefly reviewing the history of the regime and the construction of the canal and its development. 1500 w. Naut Gaz—Aug. 3, 1905. No. 71211.

The Semi-Centennial of the Soo Canal. Illustrates the first lock constructed in America, and the present locks of the Sault Ste. Marie Canal, giving some information concerning the immense traffic. 800 w. Marine Engng—Aug., 1905. No. 71119 C.

The Value of Our Canals, and What We Ought to do With Them. Discusses the British canal situation. 3000 w. Elec Rev, Lond—Aug. 18, 1905. No. 71629 A.

Coal Pockets.

Coal Pockets in the Harbor of Hamburg (Kohlenkipper im Hamburger Hafen). Describing the newly installed appliances for handling coal for the vessels of the Hamburg-American Line at Hamburg. 1500 w. Zeitschr d Ver Deutscher Ing—July 29, 1905. No. 71508 D.

Cranes.

Electrically Driven Harbor Crane (Elektrisch Betriebener Werft-Drehkran). Illustrating and describing a 120 ton radical harbor crane, constructed for the Austrian Lloyds. 3000 w. 1 Plate. Zeitschr d Ver Deutscher Ing—Aug. 5, 1905. No. 71509 D.

The Electric Cranes in the Harbor of Cologne and Deutz (Die Elektrisch Betriebenen Krane im Cöln-Deutzer Hafen). Kurt Perlewitz. With views and details of the traveling portal cranes used on the Rhine front, using the 50 cycle current of the city supply direct. 3500 w. Elektrotech Zeitschr—Aug. 10, 1905. No. 71564 B.

Electric Power.

The Electrical Equipment of Manaos Harbor, Amazon River. Charles J. Seibert. A short illustrated description of a system for handling cargo, which has proved very successful. 1200 w. Elec Wld & Engr—Aug. 19, 1905. No. 71436.

Flow.

The Irregular Flow of Rivers in Humid Prairie States. F. W. Hanna. In the opinion of the writer, the changes under discussion have been caused by pasturage, drainage, and cultivation mainly. 1500 w. Eng News—Aug. 3, 1905. No. 71179.

Harbors.

Fishguard Harbor Works. H. G. Archer. Illustrated description of the harbor works for the Irish service of the Great Western Railway. This new route will shorten the distance 100 miles in many cases between places in England and Ireland. 2000 w Engng—Aug. 11, 1905. No. 71461 A.

River Improvement.

Land Reclamation Along the Illinois River. Describes the method used in reclaiming large tracts of land on both sides of the Illinois River, and the flood protection of ten tracts varying from 3000 to 15000 acres each. Ills. 1500 w. Eng Rec—Aug. 5, 1905. No. 71239.

Sea Walls.

Some Notes on Sea Protective Works on the North Coast of Jamaica. J. Monk Fletcher. An explanation of conditions and description of repair work. 1500 w. Eng Rec—Aug. 5, 1905. No. 71237.

The Great Sea Wall at Galveston. W. S. Hudson. Brief illustrated description of this recently completed great sea wall. 1000 w. Sci Am—Aug. 26, 1905. No. 71486.

Shears.

Heavy German Shears and Presses Frank C. Perkins. Illustrated descriptions of large machines operated by hydraulic and steam power. 2400 w. Ir Age—Aug. 17, 1905. No. 71374.

ELECTRICAL ENGINEERING

COMMUNICATION.

Africa.

The Telegraph Lines of Africa (Die Telegraphenlinien in Afrika). Hans V. Hellrigl. A review of the existing lines and those under construction. 2000 w. Zeitschr f Elektrotechnik—Aug. 6, 1905. No. 71577 D.

Autotelegraph.

The Cerebotani Autotelegraph. Illustrated description of this apparatus for the telegraphic transmission of writing and its operation. 1400 w. Sci Am Sup —Aug. 5, 1905. No. 71188.

Cables.

Submarine Cables (Ueber Unterseekabel). Hermann Hilderbrandt. A general review of the growth of the submarine cable service of various parts of the world. Serial. Part I. 2500 w. Schiffbau—Aug. 9, 1905. No. 71592 D.

Space Telegraphy.

Governmental Wireless Telegraphy on the Pacific Coast. Waldon Fawcett. An account of recent extensions, and report of successful long-distance transmission, and some idea of the commercial messages transmitted. Ills. 800 w. Elec Rev, N Y—Aug. 5, 1905. No. 71213.

Massic System of Wireless Telegraphy. A. Frederick Collins. An illustrated description of the apparatus used. The chief features relate to the receptor and a controlling device for switching in and out simultaneously the oscillophone, the transformer and the motor-generator. 1800 w. Elec Wld & Engr—July 29, 1905. No. 71134.

Subsidiary Apparatus of the Telefunken System. A. Frederick Collins. Describes changes that were necessary in the devices used in this combination system of wireless telegraphy, illustrating the field outfit, and other apparatus. 2000 w. Elec Wld & Engr—Aug. 12, 1905. No. 71328.

The Artom System of Directed Wireless Telegraphy (Richtfähige Telegraphie ohne Draht nach Artom). Describing the successful application of the principle of Righi for projecting electrical oscillations in a single right-line direction. 1500 w. Elektrotech Zeitschr—Aug. 3, 1905. No. 71562 B.

The Metallic Point Electrolytic Detector (Le Détecteur Electrolytique à Pointe Métallique). G. Ferrié. Showing the manner in which a device consisting of a platinum point in imperfect contact with an electrolyte such as sulphuric acid may be used to receive Hertzian waves. 1000 w. Comptes Rendus—July 31, 1905. No. 71527 D.

Wireless Telegraphy Measurements. W. Duddell and J. E. Taylor. Read before the Inst. of Elec. Engrs. an account of preliminary tests made by the authors for the Postal Telegraph Department to measure the R. M. S. value of the current in the receiving air wire and to determine, as far as possible, how this current depends on the arrangement of the transmitting and receiving apparatus and the distance between them. Ills. 2500 w. Elec Engr, Lond—Aug. 11, 1905. Serial. 1st part. No. 71455 A.

Telephony.

An Austrian Inductive Telephone Trunk Line. Abstract translation of an article by Herr R. Nowotny, describing a successful experiment made in Austria on the insertion of inductance coils in long telephone lines. Ills. 1700 w. Elect'n, Lond—Aug. 11, 1905. No. 71458 A.

Development and Future Tendencies of the Telephone Art. Edward E. Clement. Abstract of a paper prepared for the Nat. Interstate Tel. Assn. A review of past and present practices, and a brief discussion of improvements and changes to be expected. 2500 w. Elec Rev, N Y—Aug. 19, 1905. No. 71431.

Safety Appliances for Use with Weak Currents (Beitrag zur Konstruktion Elektrischer Sicherungen für Schwachstromanlagen). Hans Carl Steidle. Describing a device to protect the user of a telephone from the action of atmospheric discharges. 1200 w. Elektrotech Zeitschr—July 20, 1905. No. 71558 B.

Telephone Service and Rates in New York. Extracts from the report made by the Merchants' Association on this question. 6000 w. Elec Rev. N Y—Aug. 5, 1905. No. 71214.

The Central Battery System in the Austrian Telephone Exchange (Das Zentral Batterie System in Oesterreichischen Telephon Zentralen). Emil Müller. A general description of the modern equipment of telephone exchanges in Austria. Three articles. 7500 w. Zeitschr f Elektrotechnik—July 9, 16, 23, 1905. No. 7157? each D.

The Railway Telephone Service; Cost of Line Construction. Frank F. Fowle. A discussion of the cost of construction, maintenance and operation and matters relating to economy in the operation of railways. 5500 w. Tech Qr—June, 1905. No. 71146 E.

We supply copies of these articles. See page 159.

Transfer Systems and the Multiple Board in Telephone Exchanges. Arthur V. Abbott. This opening article explains these two systems. 1800 w. Elec Wld & Engr—July 29, 1905. Serial. 1st part. No. 71135.

DISTRIBUTION.

Circuits.

A Study of Circuits Containing Resistance, Inductance, and Capacity by Means of the Circle-Diagram. J. S. Dow and F. Creedy. An attempt to apply the circle-diagram to the study of circuits containing resistance, self-induction, and capacity. 2200 w. Elec Engr, Lond—Aug. 4, 1905. No. 71354 A.

Three-Wire.

Three-Wire Distribution for Factories. Ralph W. Birkett. Remarks on the advantages of a three-wire system, describing one installed by the author at a large engineering works. 4000 w. Elect'n, Lond—July 21, 1905. No. 71159 A.

Transformers.

A Simple Graphical Method of Determining the Pressure Drop in Transformers (Ueber eine Einfache Graphische Ermittelung des Spannungsabfalles bei Transformatoren). Walter Hahnemann. Showing the application of the circular diagram of Kapp, giving results within 10 per cent. 1500 w. Elektrotech Zeitschr—July 27, 1905. No. 71560 B.

Central Station Transformer Testing. William Nesbit. Gives directions for making the copper loss test, regulation test, ratio test, and insulation test. 2200 w. Elec Jour—Aug. 1905. No. 71315.

Transformers. R. T. MacKeen. Read before the Can. Elec. Assn. A general discussion upon the characteristics of lighting and power transformers as used for pole suspension in sizes limited to 50 K W. and less. 5000 w. Can Elec News—Aug. 1905. No. 71489.

ELECTRO-CHEMISTRY.

Accumulator.

The Edison Nickel-Iron Storage Battery (Der Eisen-Nickelakkumulator nach System Edison). M. U. Schoop. A very full description of the latest type of Edison alkaline accumulator, with data and results of tests. 8000 w. Elektrotech Zeitschr—Aug. 17, 1905. No. 71569 B.

Electric Furnaces.

Accessory Equipment of Electric-Furnace Plants. M. M. Green. Discusses the raw materials and various stages of manufacture. 2000 w. Eng & Min Jour—Aug. 26, 1905. No. 71603.

Electrically-Heated Carbon Tube Furnaces. R. S. Hutton and W. H. Patterson. Read before the Faraday Soc. An illustrated account of the authors' work with there furnaces and the results. 2500 w. Sci Am Sup—Aug. 19, 1905. Serial. 1st part. No. 71395.

Industrial Resistance Furnaces. F. A. J. FitzGerald. Considers the Gin, Colby, and Kjellin furnaces. Ills. 1500 w. Elec-Chem & Met Ind—Aug. 1905. No. 71272 C.

The Electric Furnace in Steel Making. Extract from an article by F. W. Harbord, in the London *Times*, concerning the place the electric furnace may be expected to take in the British steel industry. 1800 w. Ir Age—Aug. 24, 1905. No. 71473.

The Galbraith Electric Furnace. Illustrates and describes a furnace designed to deal specially with the iron sands found in large quantities at Calliope Dock, Auckland, New Zealand, and elsewhere. 1200 w. Elec Engr, Lond—July 21, 1905. No. 71155 A.

The Refining of Steel in the Electric Furnace (Ueber Gewinnung von Stahl im Elektrischen Ofen). Viktor Engelhardt. A general review of electric smelting methods followed by a discussion of the Kjellin induction furnace. Serial. Part I. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 5, 1905. No. 71551 D.

Electrolytic Analysis.

Suggestions for the Equipment of an Electro-Analytical Laboratory. Dr. Rudolf Gahl. Read before the W. Assn. of Tech. Chem. & Met. Discusses the electrical current and how best to produce it, and the application of this system for practical use. 2500 w. Min Rept—Aug. 10, 1905. No. 71321.

Electro-Metallurgy.

The Rapid Electro-Deposition of Copper. Sherard Cowper-Coles. Read before the Faraday Soc. An illustrated discussion of the various processes tried for increasing the current desired by using mechanical means for keeping the copper from getting rough. 2200 w. Min Jour—Aug. 5, 1905. Serial. 1st part. No. 71344 A.

Electroplating.

The Chemistry of Electroplating. Wilder D. Bancroft. Presents the most recent facts relating to the electrolytic precipitation of the metals. 2500 w. Jour Fr Inst—Aug. 1905. No. 71294 D.

Electrotyping.

Electrotyping. Dr. F. Mollwo Perkin, in *Knowledge and Scientific News*. Describes the processes of electrotyping, facing and stereotypes, reproduction of gramophone records, etc. 1700 w. Sci Am Sup—Aug. 5, 1905. No. 71187.

Formulae.

On the Fundamental Formulæ of Chemical and Electrical Energy. Prof. F. Haber. Notes these different stages in the development of knowledge of the relation between heat of reaction and energy of reaction, discussing each and especially considering the simplification possible. 1500 w. Elec-Chem & Met Ind—Aug., 1905. No. 71270 C.

Ozone.

Improvements in the Electrical Generation of Ozone (Neuerungen auf dem Gebiete der Erzeugung des Ozons auf Elektrischem Wege). Dr. O. Kausch. A review of recent patents, with illustrations and details of apparatus. Two articles. 3000 w. Elektrochemische Zeitschr—July, Aug., 1905. No. 71593 each G.

Metallic Arc.

The Electrochemistry of the Metallic Arc. Isador Ladoff. The object of the article is to review the literature treating of the metallic arc, and to give the results of the writers' work in this field. 1800 w. Elec-Chem & Met Ind—Aug., 1905. Serial. 1st part. No. 71273 C.

Ozone.

The Production and Utilization of Ozone. Arthur W. Ewell. Explains three methods of producing ozone, referring to a number of ozonizers, and to applications made of ozone. 1800 w. Elec Wld & Engr—Aug. 12, 1905. No. 71327.

Raw Materials.

The Sources of Raw Materials for Niagara's Electrochemical Industries. Morris M. Green. Discusses in detail the most convenient sources and the approximate cost of the salt, coke, pure glass sand, anthracite coal, and lime used. 800 w. Elec-Chem & Met Ind—Aug., 1904. No. 71271 C.

ELECTRO-PHYSICS.

Dielectrics.

A Contribution to the Study of Liquid Dielectrics (Contribution à l'Etude des Dielectriques Liquides). P. Gourée de illemontée. Experiments upon the behavior of petroleum and of paraffine oil when used as a dielectric in electrical condensers. 1200 w. Comptes Rendus—July 17, 1905. No. 71525 D.

Eddy Currents.

Eddy-Current Losses in the Armature Copper of Electrical Machines (Wirbelstromverluste im Ankerkupfer Elektrischer Maschinen). Bruno Loewenherz and A. H. van der Hoop. A description of experimental investigations, the results being plotted in curves. 3000 w. Elektrotech Zeitschr—Aug. 17, 1905. No. 71570 B.

Hysteresis.

Experiments on the Work of the Iron in Polyphase and Alternating Fields (Versuche über die Eisenarbeit im Dreh und Wechselfeld). J. Herrmann. Experiments to show the relative hysteresis loss in polyphase and linear alternating fields. 3500 w. Elektrotech Zeitschr—Aug. 10, 1905. No. 71565 B.

Radioactivity.

Some Experiments Upon the Radioactivity of Uranium (Sur quelques Expériences Relatives à l'Activation par l'Uranium). Henri Becquerel. Results of experiments with uranium salts under various conditions of temperature. 1800 w. Comptes Rendus—July 10, 1905. No. 71523 D.

Rectifier.

The Influence of the Electrolyte upon the Action of the Aluminum Rectifying Cell (Der Einfluss des Elektrolyten auf die Wirksamkeit der Aluminum Drosselzelle). Dr. Franz Peters and Dr. A. E. Lange. Describing experiments with the electrolytic cell for rectifying alternating currents; extending the researches of Mott. 2500 w. Elektrotech Zeitschr—Aug. 10, 1905. No. 71566 B.

Solenoids.

The Mechanical Efficiency of Solenoid Magnets (Die Mechanische Arbeitsleistung von Hubmagneten). Paul Schieman. An application of the law of the conservation of energy to the performance plunger armatures in solenoid coils. 1500 w. Zeitschr f Elektrotech—Aug. 13, 1905. No. 71578 D.

GENERATING STATIONS.

Armature Losses.

Armature Losses in Double-Current Generators. Alfred Still. Gives diagrams showing what takes place in the armature windings of a double-current generator, with explanation. 1600 w. Elec Wld & Engr—Aug. 12, 1905. No. 71326.

Clyde.

The Clyde Valley Electrical Power System, Glasgow, Scotland. Illustrated description of the Yoker generating plant, with an outline of the power scheme to serve the most important manufacturing and coal producing district of Scotland. 2200 w. Elec Wld & Engr—Aug. 5, 1905. No. 71233.

Dynamos.

Acyclic Dynamos (Les Dynamos Acycliques). A general review of the homopolar type of dynamos, generating continuous currents without commutators and especially adapted for high rotative speeds. 2500 w. Génie Civil—July 29, 1905. No. 71519 D.

Continuous-Current Dynamos with Auxiliary Poles (Gleichstrommaschinen mit Hülfspolen). Max Breslauer. Experiments to determine the proper dimensions of commutation poles. 6000 w. Elektrotech Zeitschr—July 13, 1905. No. 71555 B.

Labor Saving Formulæ. Julius Frith. Gives examples illustrating the use of formulæ in the design of direct current dynamos, especially with regard to high speeds. 1800 w. Elec Engr, Lond—Aug. 4, 1905. No. 71357 A.

Notes on Pole Changing Machines (Bemerkungen über Wendepolmaschinen). A. Rotth. Comparative results obtained with two and four-pole dynamos with change magnets between the field magnets. 1500 w. Zeitschr f Elektrotechnik—Aug. 6, 1905. No. 71576 D.

Electric Plants.

Some Suggestions on Operation and Construction in the Electric Department. George C. Holberton. Read before the Pacific Coast Gas Assn. General suggestions on the selection and care of meters, the character of the service, etc. 3500 w. Jour of Elec—Aug., 1905. No. 71419 C.

Gas Power.

Utilization of Gas Engines in Connection with Long Distance Electric Transmission. Jno. Martin. Read before the Pacific Coast Gas Assn. Brief account of the use of gas engines by the California Gas & Electric Corporation, describing the engines now being built. 2000 w. Jour of Elec—Aug., 1905. No. 71418 C.

Utilization of Gas Engines in Connection with Long-Distance Electric Transmission. John Martin. Read before the Pacific Coast Gas Assn. Information concerning the application of gas engines in California, in which the gas used is derived from crude oil. 2000 w. Elec Wld & Engr—Aug. 5, 1905. No. 71234.

Generating System.

Generating System of the Portland General Electric Co. F. G. Sykes. From a paper read before the Engineering Congress at the Lewis and Clark Exposition. Illustrated detailed description of the works. 3700 w. Eng Rec—Aug. 12, 1905. No. 71331.

Hydro-Electric.

Electric Power Developments at Niagara Falls. Gives a view showing the location of the new power plants with reference to the Falls, and begins an illustrated description of the plant of the Ontario Development Company. 2500 w. Sci Am—Aug. 12, 1905. Serial. 1st part. No. 71282.

Electric Power Development at Portland, Ore. Illustrated description of the new station of the Portland General Electric Co., at Willamette Falls. 1600 w. Elec Wld & Engr—July 29, 1905. No. 71133.

Hydro Electric Developments of the Ontario Power Company. Begins an illustrated detailed description. The present number outlines the general plan and describes the intake works. 3000 w. Elec Wld & Engr—Aug. 26, 1905. Serial. 1st part. No. 71614.

Hydro-Electric Development in Norway. L. Ramakers. An illustrated description of the electric generating station at Glommen, near Kykkelsrud. 1500 w. Am Electr'n—Aug., 1905. No. 71147.

Hydro-Electric Power Station, California Gas & Electric Corporation, de Sabla, Cal. Illustrated detailed description of a power station, having a generator of 5000-K W. capactity, run by a single water wheel operating under a static head of water of 1528 ft. 3000 w. Eng News—Aug. 10, 1905. No. 71274.

Some of the Electrical Developments in Oregon. C. M. Hyckell. Illustrates and describes various projects for the utilization of water power. 2000 w. Elec Rev, N Y—Aug. 12, 1905. No. 71309.

The Hydro-Electric Plant at Beznau. C. L. Durand. An illustrated description of an important Swiss central supply station. 1500 w. Elec Rev, N Y—Aug. 19, 1905. No. 71434.

Lighting Station.

The Electric Station of the Baden State Railways at Durlach (Das Elektrizitätswerk der Badische Staatseisenbahnen bei Durlach). K. Freyss. An illustrated description of the new station furnishing current for lighting the buildings of the Baden railway system. 3500 w. Elektrotech Zeitschr—Aug. 10, 1905. No. 71567 B.

The System of the Portland General Electric Company. F. G. Sykes. A general review of the development of electricity in Portland, and a fully illustrated description of the plant deriving more than 30,000 h. p. from the falls of the Willamette River and transmitted electrically to Portland. 10800 w. Jour of Elec—Aug., 1905. No. 71417 C.

Parallel Running.

"Flywheel Effect" and "Stored Energy" in Rotating Parts of Electrical Machinery, and the Parallel Running of Alternators. Compares English and Continental practise, and the conversion of one system to the other is explained, giving example. 2000 w. Elec Engr, Lond—Aug. 18, 1905. No. 71628 A.

Operation of Alternators in Parallel. A. L. Mudge. Read before the Can. Elec.

Assn. Considers some of the advantages secured by parallel operation, the requirements, and points in practical operation. 7500 w. Can Elec News—Aug., 1905. No. 71490.

Power Station.

Steel Work of the Marion Power Station, Public Service Corporation of New Jersey. Illustrated description of a power house in Jersey City, designed for an installation of boilers and Curtis Turbo-Generators of about 64,000 K W. ultimate capacity. 1800 w. Eng Rec—Aug. 19, 1905. No. 71441.

Pressure.

The Kinetic Variation of Pressure in Electric Generators. Alexander Russell. Points out that it is inconsistent to specify the drop in the terminal pressure of electric generators from no-load to full-load without stating the rate at which the voltage shall decrease with the speed. Gives a method of finding the kinetic factor. 2000 w. Elect'n, Lond—Aug. 4, 1905. No. 71358 A.

Pull.

The Lateral Magnetic Pull of Dynamos and Motors (Der Einseitige Magnetische Zug von Dynamos und Motoren). F. Niethammer. Deriving formulas for computing the lateral magnetic effort due to eccentricity in construction. 1000 w. Zeitschr f Elektrotechnik—July 9, 1905. No. 71571 D.

Venice.

The Electric Station at Venice (Das Elektrizitätswerk Venedig). F. Niethammer. A general description of the Cellina hydro-electric station, supplying the city of Venice with current for light and power. 2000 w. 2 plates. Zeitschr f Elektrotechnik—Aug. 6, 1905. No. 71575 D.

LIGHTING.

Illuminated Signs.

Sign and Decorative Lighting. La Rue Vredenburgh. Deals only with the commercial side of the subject. 2500 w. Cent Sta—Aug., 1905. No. 71267.

Lighting Station.

See Electrical Engineering, Generating Stations.

Nernst.

Inter-Relation of Ballast and Glower in the Nernst Lamp. Lewis A. Terven. An outline study of the problems presented by the glower and the ballast showing how they combine to make the lamp. 2500 w. Elec Wld & Engr—Aug. 19, 1905. No. 71435.

Photometry.

The Photometry of Unsymmetrical Sources of Light (Ueber die Photometrie Unsymmetrischer Lichtquellen). L. Bloch. Showing how the observation of a limited number of values will enable a fair average result to be obtained. 1800 w. Elektrotech Zeitschr—July 13, 1905. No. 71556 B.

Street Lighting.

Street Lighting by Incandescent Lamps. John Howatt. Describes briefly the two general systems used in operating incandescent lamps for street lighting. 1400 w. Am Elect'n—Aug., 1905. No. 71149.

Subway Lighting.

The Illumination of the Subway Stations. E. Leavenworth Elliott. Discusses the faults of the present system of lighting the New York Subway, and the means of overcoming them. 2500 w. Elec Rev, N Y—Aug. 26, 1905. No. 71498.

MEASUREMENT.

Galvanometers.

Marine Galvanometer and Adjustable Universal Shunt Used as a Direct-Reading Milammeter or Voltmeter. J. Rymer-Jones. Gives particulars showing how a galvanometer may be employed as a very sensitive milammeter, and also for a sensitive voltmeter. 1800 w. Elec Rev, Lond—Aug. 11, 1905. No. 71456 A.

High Temperatures.

The Electrical Measurement of High Temperatures. H. S. Knowlton. Explains the merits of the Le Chatelier pyrometer. 900 w. Cassier's Mag—Aug., 1905. No. 71385 B.

Measuring Instruments.

Discussion on Measuring Instruments at Philadelphia, May 8, 1905; Pittsburg, Pa., May 8, 1905; and San Francisco, May 9, 1905. 7000 w. Am Inst of Elec Engrs—Aug., 1905. No. 71404 D.

The Handling of Electrical Instruments in Relation to Their Accuracy. H. B. Taylor. Discusses the location of instruments where they will not be affected by other pieces of apparatus or by the conducting current. Considers the stray magnetic field, correction for energy losses, zero errors, and the precautions necessary in handling. 3500 w. Elec Jour—Aug., 1905. No. 71316.

Meters.

Discussion on "Some Notes on Polyphase Metering," "Notes on the Use of Instruments on Switchboards," and "Maintenance of Meters," at New York, April 28, 1905. 5000 w. Am Inst of Elec Engrs—Aug., 1905. No. 71403 D.

Oscillograph.

The Siemens & Halske Oscillograph (Der Ozillograph der Siemens & Halske Aktiengesellschaft). W. Hornauer. A description of the apparatus with reproductions of the curves produced by various types of generators. Two articles. 5000 w. Zeitschr f Elektrotechnik—July 16, 23, 1905. No. 71573 each D.

Wave Lengths.

The Measurement of the Wave Lengths of Electric Oscillations (Ueber die Messung der Wellenlänge Elektrischer Schwingungen). E. Gehrcke. Describing the apparatus and methods used at the Physikalisch Technisch Reichsanstalt. 3000 w. Elektrotech Zeitschr—July 27, 1905. No. 71559 B.

MOTORS.

Commutation.

Reactance E. M. F. and the Design of Commutating Machines. C. A. Adams. Explains a formula developed by the writer which makes possible a rational determination of the minimum safe number of commutator bars, and shows the manner in which the several fundamental design constants affect the commutation. 2000 w. Elec Wld & Engr—Aug. 26, 1905. No. 71615.

Induction Motors.

The Design of Induction Motors. H. M. Hobart. The first of a series of articles giving a consistent plan of design. 600 w. Elec Mag—July 29, 1905. Serial. 1st part. No. 71382 A.

Motors.

A Traction Motor for Continuous and Alternating Current. Describes a car equipped with the Winter-Eichberg motors, which can be driven either by continuous or alternating-current. From the *Elektrotechnische Zeitschrift*. Ills. 1000 w. Elec Engr, Lond—Aug. 4, 1905. No. 71356 A.

Winter-Eichberg.

The Theory of the Winter-Eichberg Motor (Zur Theorie des Winter-Eichberg Motors). Dr. L. Fleischmann. Giving both graphical and analytical treatment, and deriving equations for the computation of the turning moment. 2500 w. Elektrotech Zeitschr—Aug. 17, 1905. No. 71568 B.

TRANSMISSION.

Lightning Arresters.

Protective Apparatus. N. J. Neall. Illustrates various types of lightning arresters, discussing present American practice for high voltage transmission cir cuits. 3000 w. Elec Jour—Aug., 1905 No. 71317.

High Voltage.

A French 28,000-Volt Power Transmission. Illustrated description of a high-voltage plant recently placed in service to supply power to Toulon. 2400 w. Elec Rev, Lond—July 21, 1905. No. 71157 A.

Lines.

Notes on Aerial Power Lines. Considers the problems underlying the elementary principles of the construction of line wires and their supports. 1500 w. Elec Engr, Lond—Aug. 11, 1905. Serial. 1st part. No. 71453 A.

Long Distance.

Conductors for Long-Distance High-Voltage Alternating Currents (Die Fernleitung Hochgespannter Wechselstrome). G. Rössler. With diagrams for the proportions of conductors, and tables of results for various distances. 6000 w. Elektrotech Zeitschr—Aug. 3, 1905. No. 71563 B.

Towers.

The Use of Steel Towers and Wooden Poles. Alton D. Adams. Notes the growing use of steel towers to support long distance transmission lines, giving examples of both kinds of line construction, and their approximate cost, and the advantages claimed for steel towers. Ills. 3300 w. Elec Rev, N Y—Aug. 19, 1905. No. 71432.

INDUSTRIAL ECONOMY

Cost Keeping.

Cost Keeping in Construction and Contract Work. John P. Cowing. A description of the practical methods employed in keeping the cost accounts in bridge construction work, with forms and records. 2000 w. Engineering Magazine—Sep., 1905. No. 71661 B.

Education.

Commercial Training for Engineers. R. D. Summerfield. Outlines the training the writer considers essential for a successful engineer, especially the importance of a business education. 2000 w. Engng—Aug. 18, 1905. No. 71631 A.

Professional Instruction in Public Works (L'Enseignement Professionnel des Travaux Publics). Col. G. Espitallier. A description of the school at Paris and the annex now being constructed at Arcueil. 3000 w. 1 plate. Génie Civil—Aug. 12, 1905. No. 71521 D.

Technical Education for Foundrymen. Prof. A. Humboldt Sexton. Read before the British Found. Assn. Discusses the subjects that should be included, and the advantages and value of the education acquired. 2800 w. Mech Engr—Aug. 19, 1905. No. 71626 A.

The Practical Utility of Manual and Technical Training. William Barclay Parsons. An address before the Nat. Ed. Assn. Discussing the subject from the point of view of results achieved and of ends to be attained. 3800 w. Eng Rec—Aug. 12, 1905. No. 71333.

Exposition.

The Lewis and Clark Exposition. Waldron Fawcett. Illustrated description of the grounds and buildings of the several States, with special reference to the mining exhibits. 4200 w. Mines & Min—Aug., 1905. No. 71202 C.

The Liége Exhibition. Remarks on the exhibition as a whole, and the lessons which it can convey. 3000 w. Engr, Lond—Aug. 11, 1905. Nofl 71465 A.

The Liége International Exposition (L'Exposition Internationale de Liége). L. Ramakers. A fully illustrated description, with plan and views of the various buildings. 3000 w. Génie Civil—July 22, 1905. No. 71515 D.

Japan.

Japanese Industrial Conditions. The first of a series of articles on the recent progress and future prospects of Japan. The present number discusses the coal-mining, and the development of the mining industry. Also editorial. 3000 w. Ir & Coal Trds Rev—July 28, 1905. Serial. 1st part. No. 71260 A.

Municipal Plants.

Financial Results of Municipal Electric Plants (Finanzielle Ergebnisse Städtischer Elektrizitätswerke). Fritz Hoppe. A review of the commercial operation of electric plants in the various cities of Germany, based on data for 1903. 7500 w. Elektrotech Zeitschr—July 20, 1905. No. 71557 B.

Rates.

Regulation of Gas and Electric Rates in Massachusetts. Alton D. Adams. Gives a collection of cases, involving gas and electric rates, which have come before the Massachusetts Commissioners, giving the facts that determined the rates, and the reasons, without any expression of opinion. 2200 w. Elec Wld & Engr—Aug. 19, 1905. Serial. 1st part. No. 71437.

Shop Superintendent.

The Training of the Modern Shop Superintendent. Charles C. Johnson. On the training given at technical schools, considering it as practical and in some ways superior to anything possible at a workshop. Ills. 1800 w. Sci Am—Aug. 26, 1905. No. 71485.

Society.

The Development and Work of the Society of German Engineers (Entwicklung und Leistungen des Vereines Deutscher Ingenieure). H. Peters. A review of the formation and growth of the organization, and the important work it has accomplished. Two articles. 4500 w. Zeitschr d Ver Deutscher Ing—July 15, 22, 1905. No. 71506 each D.

Stock-Keeping.

A Perfect Method of Stock-Keeping. J. P. Wiatt. Gives a method which the writer considers the best and most accurate system of keeping stock. 1200 w. Jour Gas Lgt—Aug. 1, 1905. No. 71343 A.

MARINE AND NAVAL ENGINEERING

Arctic Service.

Propelling Machinery for the Arctic Steamer Roosevelt. An illustrated article giving a general description of the machinery designed to meet the severe conditions of working through the ice. 1800 w. Marine Engng—Aug., 1905. No. 71117 C.

Disasters.

General Pando Hoodoo. E. Cockburn Johnstone. An interesting account of the fate of a vessel built for Bolivia, which never reached its destination. 1800 w. Marine Rev—Aug. 3, 1905. No. 71210.

Electric Power.

Application of Electric Power to Auxiliary Machinery in the Navy. L. C. Brooks. Describes the latest practice in the various applications made. Ills. 5000 w. Am Elect'n—Aug., 1905. No. 71148.

Ferryboats.

The Southern Pacific Company in Marine Work. W. H. Crawford and T. B. Burnite. Illustrated description of the train ferryboat "Solano" and its recent repairing on a specially built marine railway and of car floats on San Francisco Bay. 1500 w. Marine Engng—Sept., 1905. No. 71650 C.

The New Staten Island Ferryboats. Brief general description, with illustrations, of the ferryboat "Manhattan," 250 feet long, with a speed of 18½ knots. 400 w. Marine Engng—Sept., 1905. No. 71652 C.

Fire-Boat.

The Fire-Boat George H. Williams, of Portland, Oregon. General description, with illustrations, of a successful fire-boat which has been in service about one year. 1400 w. Marine Engng—Aug., 1905. No. 71118 C.

Fishing Boats.

Foreign Types of Fishing Boats in San Francisco Bay. E. N. Percy. Brief illustrated descriptions of unique types, including a Chinese junk, and an Italian fishing boat. 600 w. Marine Engng—Aug., 1905. No. 71116 C.

Gas Engines.

See Mechanical Engineering, Combustion Motors.

Lake Vessels.

The New Fleet on the Great Lakes. Ralph D. Williams. Gives information showing how the trade of the Great Lakes is growing and giving a list of this year's orders for new ships. Ills. 1300 w. R R Gaz—Vol. XXXIX. No. 5. No. 71226.

What of Our Commerce? Lewis M. Haupt. Gives a chart showing graphically the growth in traffic through this canal, and comparison with the Suez Canal, and urges the further improvement of these waterways. 1000 w. Marine Rev—Aug. 3, 1905. No. 71209.

Mercantile Marine.

New Passenger Steamer La Provence. L. Ramakers. Illustrated description of a new passenger steamer for service between Havre and New York, which will be the fastest and largest of the French mercantile marine. 1400 w. Marine Engng—Aug., 1905. No. 71115 C.

Models.

Experiments on Resistance of Ships' Models. G. Rota. Read before the Inst. of Naval Archts. Reports experiments with models of constant length and form of cross-sections, but with varying breadth and draught. 1500 w. Ills. Engng—Aug. 4, 1905. No. 71365 A.

Motor Boats.

Motor Yacht Club's Reliability Trials, 1905. Tabulated results, illustrations and interesting report of the second annual reliability trial for motor boats in Southampton Water and the Solent. 4800 w. Auto Jour—Aug. 12, 1905. No. 71447 A.

The New Auto-Boat Veritas. Illustrated description of 56-foot boat, with 8-cylinder gasoline engine of 175 horse power. 1500 w. Marine Engng—Sept., 1905. No. 71651 C.

Naval Ships.

Naval Ships at the Time of Trafalgar. Sir Philip Watts. Read before the Inst. of Naval Archts. Enumerates and classifies the types of ships forming the Royal Navy at that time, describing briefly the design, construction, armament, etc., of some of the more important. Ills. 4000 w. Engng—July 28, 1905. No. 71254 A.

Naval Strategy.

Naval Strategy and Tactics at the Time of Trafalgar. Admiral Sir Cyprian Bridge. Read before the Inst. of Naval Archts. Outlines the general plans and considers points which may furnish guidance of value at the present day. 5000 w. Engng—July 21, 1905. No. 71164 A.

Scouts.

Notes on the Trials of H. M. S. Adventure. Illustrates and describes this vessel, of the Scout class, and its equipment, giving tabulated results of the official trials. 2700 w. Engr, Lond—Aug. 4, 1905. No. 71368 A.

The English Scout-Cruiser Sentinel. Emile Guarini. Illustrated general description of 25-knot, 2920-ton, 17500 horse power vessel, 340 feet long, built by Vickers Sons & Maxim, Ltd., and her trial trip. 800 w. Marine Engng—Sept., 1905. No. 71649 C.

Screw Propellers.

Rankine of the Screw Propeller. Reprint of an article appearing in this paper No. 2, 1866, setting forth the theory of the propulsion of vessels by jets. 1700 w. Engr, Lond—Aug. 4, 1905. No. 71373 A.

Shipbuilding.

The Dockyards and Shipbuilding Plants of Japan. Charles Albertson. A fully illustrated description of the facilities for shipbuilding at present existing in Japan. The first paper deals with the government yards. 3000 w. Engineering Magazine—Sept., 1905. No. 71656 B.

Sounding.

The Acoustic Method of Sounding (Procédés Acoustiques pour le Sondage). Ch. Dantin. A review of experiments made in the United States, England and Denmark for determining the depth of water by acoustic methods, and for submarine signalling between vessels. 1800 w. Génie Civil—July 22, 1905. No. 71517 D.

Speed.

The Influence of Depth of Water on the Speed of Destroyers. Harold Yarrow. Read before the Inst. of Naval Archts. An illustrated article discussing trials and experiments, having special reference to recently built destroyers. 1800 w. Engng—July 21, 1905. No. 71165 A.

The Influence of Depth of Water on Speed. W. W. Marriner. Read before the Inst. of Naval Archts. Gives deductions drawn from recent and former experiments, especially investigating surface disturbance or wave-making resistance. 2000 w. Engng—July 21, 1905. No. 71166 A.

Submarines.

Submarine Boats and Their Salvage. Capt. R. H. Bacon. Read before the Inst. of Naval Archts. Discusses the causes of accidents to submarine boats, the means of preventing their occurrence, and the methods of raising such vessels. Also editorial. 8000 w. Engng—July 28, 1905. No. 71255 A.

Turbine Propulsion.

Comparison of Turbines and Reciprocating Engines in Steamers. William Gray. Read before the Inst. of Naval Archts. Gives particulars in regard to the working of the Midland Railway Company's steamers for the Irish and Isle of Man service, two being fitted with turbines and two with reciprocating engines. 2000 n. Mech Engr—July 22, 1905. No. 71154 A.

Speedy English Turbine Steamer. Illustrates and describes the Viking, plying out of the port of Liverpool. Speed about 27 miles an hour. 1500 w. Naut Gaz—Aug. 10, 1905. No. 71320.

The Allen Line Turbine Steamers Victorian and Virginian. Benjamin Taylor. General illustrated description of 19½-knot, 12000 horse power, 10,600-ton, 540-foot vessels, plying between Liverpool and Montreal. 1000 w. Marine Engng—Sept., 1905. No. 71648 C.

The Turbine-Driven Channel Steamer Dieppe. Illustrated description of the vessel and its machinery, with results of the official trial and remarks. 2300 w. Engng—Aug. 18, 1905. No. 71632 A.

Turbines and Reciprocating Engines in the Midland Railway Company's Boats. William Gray. Read before the Inst. of Naval Archts. A comparison of the performances of vessels, two being fitted with reciprocating engines and two with Parsons marine turbines. 2500 w. Engng—Aug. 4, 1905. No. 71364 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air Cooling.

Handling of an Air-Cooled Gasoline Car. Harry B. Haines. Begins a detailed discussion of these cars and the care needed to handle them successfully. 1600 w. Automobile—Aug. 10, 1905. No. 71279.

Buckboard.

How to Make an Electric Buckboard. J. C. Brocksmith. An illustrated article giving directions for the construction. 1700 w. Am Elect'n—Aug., 1905. No. 71150.

Chassis.

The 40-horse power Georges-Richard-Brasier. Illustrated description of a chassis weighing 20 cwts. Completed entirely in accordance with Gordon Bennett practice. 700 w. Autocar—Aug. 19, 1905. No. 71627 A.

Commercial Vehicles.

Notes on the Use of Commercial Cars. Henri G. Chatain. Suggestions for the proper working of these cars, their care and operation. 2000 w. Automobile—Aug. 10, 1905. No. 71278.

Typical Commercial Vehicles on Sale. Gives information concerning the work of these cars, and illustrates and describes a number of types. 8000 w. Automobile—Aug. 10, 1905. No. 71277.

Delaunay-Belleville.

The Delaunay-Belleville Petrol Cars. Illustrated description of these cars. 700 w. Auto Jour—Aug. 5, 1905. Serial. 1st part. No. 71347 A.

Differential.

How a Differential Gear Works. Drawings and description explaining the action of a differential gear. 1500 w. Autocar—Aug. 5, 1905. No. 71348 A.

Electric Truck.

The Couple Gear Electric Truck. Illustrated detailed description of these motor vehicles. There is a motor in each wheel and each motor carries two pinions at the end of its shaft, meshing with bevel gear racks on the interior of the wheel frame. 1200 w. Ir Age—Aug. 10, 1905. No. 71244.

Fiat.

The 1905 Fiat Cars. Illustrates and describes late models, noting the changes made. 1100 w. Auto Jour—July 22, 1905. No. 71151 A.

Ignition.

Electric Ignition Systems. E. W. Roberts. General explanation of electric ignition systems, with brief illustrated descriptions of the several systems. 3000 w. Sci Am Sup—Aug. 19, 1905. No. 71304.

Industrial Cars.

The French Heavy Car Trials. An account of the trials of commercial vehicles. 1500 w. Engr, Lond—Aug. 4, 1905. Serial. 1st part. No. 71370 A.

Tyres.

The Helena Tyre Outfit. Illustrates and describes a tyre detaching and attaching outfit. 1000 w. Autocar—July 22, 1905. No. 71152 A.

COMBUSTION MOTORS.

Efficiency.

"Mechanical Efficiency" in the Gas Engine. Editorial review of an interesting discussion that has been recently published in Germany concerning the meaning of the term "mechanical efficiency" in the case of gas engines. 4000 w. Eng News—Aug. 3, 1905. No. 71181.

Cylinders.

Size of Gas and Oil Engine Cylinders. Gives calculations for ordinary four-cycle single-acting engines. 700 w. Prac Engr—Aug. 11, 1905. No. 71450 A.

Gas Engines.

The Modern Gas Engine. F. E. Matthews. Reviews some of the early efforts to build gas engines, discusssing the essentials to efficiency, the operation of multiple-cycle engines, and other subjects of interest. Ills. 2200 w. Ice & Refrig—Aug., 1905. Serial. 1st part. No. 71215 C.

The Shops of the Joseph Reid Gas Engine Co., Oil City, Pa. Illustrates and describes the Reid gas engine, and the plant where it is manufactured. 2200 w. Ir Tr Rev—Aug. 3, 1905. No. 71199.

Gasoline Motors.

High-Power English Gasoline Motors for Driving American Locomotives. Describes two English motors being built for the General Electric Company, for a series of experiments with the gasoline-electric system of propulsion for locomotives. 1100 w. Sci Am Sup—Aug. 12, 1905. No. 71285.

Marine Engine.

Gas Engine with Producer for Marine Use. Illustrated description of a new type of mechanically-propelled vessel, constructed by John I. Thornycroft & Co., Ltd., and the machinery. 1500 w. Engng—Aug. 4, 1905. No. 71361 A.

HEATING AND COOLING.

Cooling.

Cooling the New York Stock Exchange. Illustrates and describes a system by which a continuous supply of fresh air is cooled and dried by apparatus of 450 tons refrigerating capacity. 2700 w. Met Work—Aug. 5, 1905. No. 71174.

Electric Heating.

Electric Heating and Cooling. George E. Walsh. States the advantages claimed for electricity in this field, and describes a number of applications for cooking, laundry work, in hospitals, etc. 3000 w. Archt's & Build's Mag—Aug., 1905. No. 71235 C.

Humidification.

Humidification in Textile Mills and Factories. H. R. Carter. States the advantages of a good humidifying system and illustrates the Drosophore humidifier as typical of local distribution humidifiers. 600 w. Prac Engr—Aug. 4, 1905. Serial. 1st part. No. 71350 A.

Japan.

A Warm Air Heating System in Kobe, Japan. Describes an installation having a large warm air cellar pipe and exhaust air ventilation passages. Ills. 2200 w. Met Work—Aug. 12, 1905. No. 71286.

N. Y. Custom House.

Heating and Ventilating New York's New Custom House. Illustrated detailed description of a notable type of the fan pressure system. 1700 w. Heat & Ven Mag—Aug., 1905. No. 71409.

Refrigeration.

Ice-Making by Electricity. Orrin E. Dunlop. Brief illustrated description of the electrically-operated ice-making plant at Niagara Falls. 900 w. Sci Am—Aug. 5, 1905. No. 71185.

Refrigeration for Office Buildings. Illustrates and describes the refrigerating plant of the First National Bank building in Chicago, and the refrigeration in the Heyworth building, run with exhaust steam. 2000 w. Ice & Refrig—Aug., 1905. No. 71216 C.

HYDRAULICS.

Flow.

The Resistance of Bends and Elbows in Pipes. Information concerning experimental investigations to determine the resistance offered by bends, knees and elbows in closed pipes, and the results. From a paper by C. W. L. Alexander, published by the Inst. of Civ Engrs. 2000 w. Eng Rec—Aug. 19, 1905. No. 71445.

Hydraulic Engines.

Hydraulic Engines at the U. S. Naval Coaling Station, Bradford, R. I. Illustrates and describes the Bradford installation. 1200 w. Eng News—Aug. 3, 1905. No. 71182.

Hydraulic Power.

Hydraulic Generation and Application of Motive Power. W. M. Barr. A review of modern hydraulic power development in the light of improved methods of regulation and application. 4000 w. Eng Mag—Sept., 1905. No. 71657 B

Niagara Power.

Power Sites About Niagara Falls. Alton D. Adams. Outlines a plan for utilizing the entire flow of the river, if desired, at a head of nearly ninety feet, and still leave the falls undiminished. 1500 w. Sci Am—Aug. 26, 1905. No. 71483.

The Intake of the Ontario Power Co. Illustrates and describes a structure built entirely of concrete, with reinforced concrete in a large part of the work, and the methods of construction. 1500 w. Eng Rec—Aug. 12, 1905. No. 71334.

Pressure Variations.

Pressure Variations in Turbine Supply Pipes (Druckschwankungen in Turbinenzuleitungsröhren). A. Budau. An exhaustive mathematical and practical investigation of the stresses in supply pipes and pen-stocks under sudden changes of flow, as in governing. Three articles. 12000 w. Zeitschr d Oesterr Ing u Arch Ver—July 21, 28, Aug. 4, 1905. No. 71535 each D.

Pumping Engine.

Pumping Engine, Rosario Water-Works. Illustrated description of a vertical triple-expansion pumping engine, working with high-pressure steam, moderately superheated. Describes also the arrangement and the advantages claimed, and gives report of test. 2000 w. Engr, Lond—Aug. 18, 1905. No. 71636 A.

Pumps.

Oil Pumps. A. L. Millar. Brief illustrated descriptions of types used in lubrication. 700 w. Am Mach—Vol. 28, No. 32. No. 71265.

Turbine Pumps.

Turbine Pumps for Irrigation and Drainage. J. J. Brown. Read before the Nat. Ir. Cong. at El Paso, Texas. Information concerning the cost of pump irrigation, giving brief reports from a number of places, and discussing various types of pumps. 2800 w. Jour of Elec—Aug., 1905. No. 71420 C.

Water-Power.

An Industrial Water-Power Plant at South Bend, Ind. Illustrated detailed description of the plant and its equipment. The governing arrangements are somewhat unusual. 1200 w. Elec Rev, N. Y. —Aug. 5, 1905. No. 71212.

MACHINE WORKS AND FOUNDRIES.

Castings.

Casting Brass or Bronze on to Iron. Walter J. May. An illustrated article giving hints that will give satisfactory results. 800 w. Prac Engr—Aug. 11, 1905. No. 71449 A.

Hot Cracks in Steel Castings. Arthur Simonson. The causes of hot cracks are explained, and ways of overcoming the difficulties are considered. 1400 w. Foundry—Aug., 1905. No. 71340.

The Presence of Sulphur in Cast Iron and its Influence on Machine Castings (Ueber die Schwefelverteilung in Gussstücken und deren Einfluss auf den Werkzeugmaschinenguss). A. Messerschmidt. Showing that the irregular distribution of sulphur in castings may cause serious local weaknesses. 3500 w. Stahl u Eisen —Aug. 1, 1905. No. 71584 D.

Cranes.

A Novel Electric Traveling Crane. Illustrated description of a novel crane in use at the yards of the Link Belt Engng. Co., Nicetown, Philadelphia, for loading and unloading cars, handling heavy castings and materials, etc. 900 w. Eng Rec —Aug. 26, 1905. No. 71624.

Electric 100-Ton Crane at Dublin. Illustrations and descriptive notes showing the general construction and electrical details of a new crane for the Port and Docks Board of Dublin. 1800 w. Elec Engr, Lond—Aug. 11, 1905. No. 71452 A.

Electric Traveling Hoists. Illustrates and describes a system of overhead traveling electric hoists, giving four views of the traveling transfer trolley service of the Ramapo Iron Company's Works at Niagara Falls. 1600 w. Am Mach—Vol. 28, No. 32. No. 71261.

Notes on Cranes—Gantries. A. D. Williams. Illustrates and describes various types. 3500 w. Am Mach—Vol. 28, No. 31. No. 71192.

Dies.

A Sectional Trimming Die. Gives plan, and side and sectional views of die, with description. 600 w. Am Mach—Vol. 28, No. 32. No. 71262.

A Set of Forging Dies. P. Sandieson. Illustrates and describes forging dies for use on a pneumatic and on a steam hammer, which serve as an example of methods used to obtain results in a modern forge. 600 w. Am Mach—Vol. 28, No. 33. No. 71377.

Eye-Bars.

Some Notes on the Development of Eye-Bar Manufacture. Joseph H. Springer, Sr. Reviews the early history of the use and manufacture of eye-bars, and traces the development and progress. 2500 w. Eng News—Aug. 17, 1905. No. 71381.

Factories.

Factory Fire Drills. H. F. J. Porter. An illustrated article briefly discussing the precautions that should be taken to insure the safety of employees in case of fire. 2000 w. Cassier's Mag—Aug., 1905. No. 71384 B.

Fans.

The Design of Centrifugal Fans. Max Buch. Gives formulæ for the design of centrifugal fans largely used in continental practice, and describes their contruction. Deals only with low-pressure fans. 1800 w. Prac Engr—July 21, 1905. Serial. 1st part. No. 71153 A.

Flanged Rings.

The Flanged Mouth-piece Rings of Vulcanizers and Similar Vessels. An illustrated article dealing with the strength of the flanged ring which is riveted to the main shell of the vessel, particularly considering one mode of failure of this ring. Also the mathematical theory of the stresses in these mouth-piece rings, etc. 11500 w. Locomotive—July, 1905. No. 71132.

Foundries.

Foundry Department of the National Transit Co., Oil City, Pa. Illustrates and describes an interesting plant which manufactures in large quantities grey iron castings, steel castings, and brass and bronze castings, all of high quality. 1400 w. Foundry—Aug., 1905. No. 71336.

Foundry Practice. Dr. Richard Moldenke. Abstract from a lecture delivered at the Case School of Applied Science, Cleveland. Discusses the work of the technical man in the foundry. 3500 w. Ir Trd Rev. Aug. 17, 1905. No. 71397.

Index Plates.

Generating a Large Index Plate. A. L. de Leeuw. Illustrates and describes the method used. 3500 w. Mach, N. Y.—Aug., 1905. No. 71141 C.

Jig.

An Indexing Drill Jig. George F. Poplewell. Drawings and description of the construction. 800 w. Am. Mach—Vol. 28, No. 33. No. 71376.

Lathes.

High-Speed Lathes. Joseph Horner. Gives illustrations of lathes designed to utilize the new high-speed cutting steels, describing them and explaining their value. 7500 w. Cassier's Mag—Aug., 1905. No. 71387 B.

108-In. Lathe for Turning Turbine-Rotors. Illustrated detailed description of a lathe built for heavy work, in which great care has been taken with details of design to increase its utility. 1300 w. Engng—July 28, 1905. No. 71253 A.

Milling Machine.

Universal Milling Machine. Illustrated description of a milling machine manufactured at Providence, R. I. 1200 w. Engng—Aug. 18, 1905. No. 71633 A.

Moulding.

Sweeping a Cylindrical and Conical Drum. H. J. McCaslin. Explains the use of these drums, describing the device employed in producing them, the method of sweeping the mold, building the core, etc. Fully illustrated. 2000 w. Foundry—Aug., 1905. No. 71337.

New Works.

An English Gear-Cutting Works. I. W. Chubb. Illustrated detailed description of new shops at Lockwood, near Huddersfield, and their arrangement and equipment. 2000 w. Am Mach—Vol. 28, No. 31. No. 71191.

Planing-Machine.

Planing-Machine for Locomotive Frame Plates. Brief illustrated description of a fine planing-machine built at Leeds, Eng. 600 w. Engng—July 21, 1905. No. 71161 A.

Repairing.

Repairing a 400-Ton Hydraulic Press. Frank M. Davis. The broken head of a powerful forcing press was replaced by a steel disk held in place by a cross bar and loop bolts secured to the cylinder lugs. 1200 w. Mach, N. Y.—Aug., 1905. No. 71142 C.

Riveting.

A Hand Pressure Riveting Machine. Dr. Alfred Gradenwitz. Illustrated description of a machine constructed by F. Arnodin with the view to obtain by hand labor rivets as satisfactory as those obtained by hydraulic pressure or other mechanical means. 400 w. Sci Am—Aug. 19, 1905. No. 71389.

Rolls.

Designing Beam Rolls. Carl Holzweiler. Abstract of an article published in *Stahl und Eisen,* giving data used by the author to lay out the rolls and then to see whether or not the design is satisfactory. Ills. 1500 w. Ir Age. Aug. 17, 1905. No. 71375.

Screws.

Standard Leading Screws for Screw-Cutting Lathes. From the report of a committee appointed by the British War Department to consider the provision of standard leading screws for screw-cutting lathes. States the difficulties surrounding the problem, the action that should be taken and gives the recommendations. 4000 w. Mech Engr—Aug. 5, 1905. No. 71352 A.

The Interchangeability of Large Screws. Reviews the report of the committee appointed by the British War Department, giving verbatim the part of the report dealing with the design and construction of the leading-screw-adjusting machine, and the recommendations. Ills. 3700 w. Engng—Aug. 4, 1905. No. 71360 A.

Shop Practice.

Toolroom and Machine Shop Practice. George R. Martin. Discusses errors due to temperature, boring in the lathe with a tool bar, keyseating gages, a crankshaft fixture, a boring tool, and a gage for ball race. Ills. 1500 w. Am Mach—Vol. 28, No. 31. No. 71193.

Stores.

Working Examples of Successful Stores Management. Walter B. Snow. A fully illustrated description of the system and methods of the B. F. Sturtevant Company, with reproductions of forms and records. 2000 w. Engineering Magazine—Sept., 1905. No. 71658 B.

Welding.

Autogenous Welding (Autogene Schweissung). Discussing the use of the oxyhydrogen and oxyacetylene blowpipes for welding, and describing the commercial production of oxygen and hydrogen for the purpose by the electrolysis of water. 2500 w. Stahl u Eisen—Aug. 1, 1905. No. 71583 D.

The Electrolytic Production of Hydrogen and Oxygen for Welding Purposes. Dr. Alfred Gradenwitz. Illustrates and describes the Schuckert apparatus which produces the oxygen and hydrogen gases by the decomposition of water. 800 w. Sci Am—Aug. 12, 1905. No. 71280.

Works.

Some French Motor Car Works. The present number gives an illustrated description of the Panhard and Levassor works at Paris, reviewing their history. 4000 w. Engr, Lond—Aug. 4, 1905. Serial. 1st part. No. 71369 A.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Alloys.

Practical Alloying. J. F. Buchanan. The present number considers ancient and modern methods of metal refining. 5000 w. Foundry—Aug., 1905. Serial. 1st part. No. 71338.

Boiler Plates.

Fractures in Large Steel Boiler Plates. J. T. Milton. Read before the Inst. of Naval Archts. Describes several cases, examining the causes of fracture, reporting tests made, discussing treatment, and investigating the subject generally. 7000 w. Engng—Aug. 4, 1905. Serial. 1st part. No. 71366 A.

Brittleness.

The Influence of Brittleness of Steel upon the Effects of Shearing, Punching and Drilling in Boiler Making (Influence de la Fragilité de l'Acier sur les Effets du Cisaillement, du Poinconnage et du Brochage dans la Chaudronnerie). Ch. Frémont. Data and results of tests upon a number of plates. 1000 w. Comptes Rendus—July 31, 1905. No. 71528 D.

Flange Tests.

Tests of Cold-Rolled Flanged Pipe Connections. Luther D. Lovekin. Gives results of a series of tests made to demonstrate the practicability of copper pipes rolled into steel flanges by machinery, and the ability of machinery to place flanges on steel pipe. Ills. 2500 w. Marine Engng—Aug.,, 1905. No. 71120 C.

Iron.

Note on the Crystallization of Wrought Iron. Prof. J. O. Arnold. Plate and description of an example of crystalline structure of iron, from a wrought-iron bolt which had been broken after 30 years' use. 1000 w. Engr, Lond—Aug. 18, 1905. No. 71637 A.

The Mechanical Properties of Iron in Isolated Crystals (Les Propriétés Mécaniques du Fer en Cristaux Isolés). F. Osmond and Ch. Frémont. Tests upon crystals of iron, showing the relation of strength to crystalline axes, and of fracture to the planes of cleavage. 1200 w. Comptes Rendus—Aug. 7, 1905. No. 71530 D.

Materials.

Mechanical Engineering Materials: Their Properties and Treatment in Construction. Edward C. R. Marks. The present article considers cast iron, giving notes, analyses, etc., from named sources. 2500 w. Prac Engr—Aug. 4, 1905. Serial. 1st part. No. 71349 A.

Pulleys.

The Bursting Strength of Wooden Pulleys. C. H. Benjamin. An illustrated article giving results of a series of experiments carried on in the laboratories of the Case School, Cleveland, Ohio. 1800 w. Mach, N. Y.—Aug., 1905. No. 71140 C.

Rivets.

Modifications in the Quality of the Metal of Rivets by the Operation of Riveting (Modification de la Qualité du Métal des Rivets par l'Opération du Rivetage). M. Charpy. Showing that the rivets may be improved or injured according to the temperature conditions. 800 w. Comptes Rendus—July 31, 1905. No. 71529 D.

Sands.

Core Sands. J. S. Robeson. Read before the A. F. A. Convention. Gives photo-micrographs, showing the variations in the sands used in core making, and that failures are often due to the sand used rather than to the binder. States the requirements for a good binder. 2200 w. Foundry—Aug., 1905. No. 71339.

Steel.

A Preliminary Report on the Effect of Combined Stresses on the Elastic Properties of Steel. Edward L. Hancock. Presented before the Am. Soc. of Test. Mat. Gives results of a series of tests on solid steel rounds in torsion while under tension, explaining methods used. Ills. 1800 w. Eng. News—Aug. 24, 1904. No. 71482.

High-Speed Steel in the Factory. O M. Becker and Walter Brown. The first of a series dealing with the problems included in the introduction of rapid-cutting steels, the whole forming a complete review of the subject. 3000 w. Engineering Magazine—Sept., 1905. No. 71660 B.

High-Speed Tool Steels (Aciers Outils à Coupe Rapide). L. Guillet. A review of the development of high-speed steels, with chemical analyses, micro-photographs, and tables of results of tests. 5000 w. 1 plate. Mem Soc Ing Civ de France—June, 1905. No. 71597 G.

Notes upon the Properties, Tests and Classification of Ternary Steels (Comparaisons des Propriétés, Essais, et Classification des Aciers Ternaires). Léon Guillet. A brief note upon the steels consisting of iron, carbon, and a third constituent, such as nickel, manganese, etc. 800 w. Comptes Rendus—July 10, 1905. No. 71524 D.

Testing Machine.

A Large Hydraulic Testing Machine for Uniform Loads. Robert A. Cummings. From a paper recently read before the Am. Soc. of Test. Materials. Illustrations with descriptions. 1100 w. Eng. Rec—Aug. 12, 1905. No. 71335.

MEASUREMENT.

Adding Machine.

The Use and Construction of the Adding Machine. Fred W. McArdle. Explains various types and their uses, the principles and the operation. 2400 w. Am Mach—Vol. 28, No. 32. No. 71263.

Anemometers.

Recording Devices for Measuring Velocity and Volume (Registrierende Geschwindigkeits und Volumenmessung). E. Stach. Illustrating and describing anemometers for obtaining records of the flow of air in mine workings for successive weeks. 3500 w. Glückauf—Aug. 12, 1905. No. 71549 D.

Calorimeter.

Measuring the Mechanical Equivalent of Heat. Illustrates and describes the invention of Prof. H. L. Callendar and its working. 800 w. Sci Am—Aug. 19, 1905. No. 71391.

Flue Gases.

Improved Methods of Flue-Gas Analysis (Neuanordrung einer Vorrichtung zur Rauchgasuntersuchung). M. Moller. Describing improvements in apparatus of the Orsat type for the analysis of the waste gases discharged by boiler and other furnaces. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 8, 1905. No. 71550 D.

Friction.

Investigations into Journal Friction according to the Method of Dettmar (Versuche über Lagerreibung nach dem Verfahren von Dettmar). H. Heimann. With description of apparatus and diagrams showing the influence of temperature, pressure and lubricants. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—July 15, 29, 1905. No. 71505 each D.

Sliding Friction (Sur le Frottement de Glissement). M. de Sparre. An examination of Painlevé's review of the theory of Coulomb, showing that the indeterminate nature of the result is only apparent. 1200 w. Comptes Rendus—July 31, 1905. No. 71526 D.

Loads.

Calculation of Loads on the Rollers of a Large Locomotive Crane. A. L. Westcott. Gives sketch showing a portion of the plan of the roller track of a 40-ton locomotive crane, and explains method of calculating the loads. 900 w. Am Mach—Vol. 28, No. 34. No. 71494.

POWER AND TRANSMISSION.

Air Discharge.

An Experimental Determination of the Coefficient of Discharge of Air. Sanford A. Moss. Gives methods used in determining the co-efficient of discharge through an orifice under actual conditions of use, with results. 4800 w. Am Mach—Vol. 28, No. 32. No. 71266.

Belt Driving.

Determining the Position of Idler Pulley for the General Care of Belt Transmission. R. N. Macalister. Explains the method of finding the position of idler pulleys in belt drives for transmitting power between shafts whose axes are not parallel. 900 w. Am Mach—Vol. 28, No. 34. No. 71493.

Bull Wheels.

Bull Wheels and Tangent Arms. W. Osborne. Explains why the arms in bull wheels are put on at a tangent to the shaft instead of radially. Ills. 700 w. Am Mach—Vol. 28, No. 32. No. 71264.

Compressed Air.

Heat of Compression in Air Cylinders and the Relation to Explosion. E. Hill.

Discusses the effects of leaks in cylinders on temperatures. 1200 w. Mines & Min —Aug., 1905. No. 71203 C.

Thermal Researches on Air Compressors (Thermische Untersuchung an Kompressoren). Fritz L. Richter. Data and results of an exhaustive series of experiments to ascertain the temperature at various stages of the process in a Riedler-Stumpf air compressor. Three articles, 7500 w. Zeitschr d Ver Deutscher Ing—July 8, 22, Aug. 5, 1905. No. 71500 each D.

Westinghouse Compound Pumps. F. H. Parke. Illustrates and describes a new design consisting of three cylinders placed vertically in tandem, explaining its working. 1700 w. Am Engr & R R Jour—Aug., 1905. No. 71139 C.

Conveyors.

Aerial Tramways in the Tug River Coal Fields. Henry Mace Payne. Illustrated description of two plants built to carry the coal mined on Kentucky side of Tug River to the railroad on the West Virginia side. 700 w. Sci Am—Aug. 19, 1905. No. 71390.

An Electrically Driven Conveyor (Eine Elektrisch Betriebene Fahrbare Kabelbahn). H. Landmann. Illustrating and describing a traveling crane and cable conveyor for handling coal. 2000 w. Zeitschr d Ver Deutscher Ing—July 22, 1905. No. 71507 D.

Developments in Machinery for Transmitting Materials. Gilbert Little. An illustrated article describing appliances for the mechanical transit of materials. 2000 w. Jour Gas Lgt—Aug. 1, 1905. No. 71342 A.

Elevators.

Electric Elevators (Elektrische Aufzuge). O. Pollok. Brief illustrated description of the electric elevator recently installed in the library of the University of Giessen. 1000 w. Zeischer d Ver Deutscher Ing—July 8, 1905. No. 71502 D.

Gearing.

Gear Designs and Manufacture. Remarks on gears as a device for the transmission of power, giving a demonstration of Reuleaux's geometrical method for "laying off" the epicycloidal teeth of gears, and discussing involute teeth, spokes or arms, hubs and the manufacture. Ills. 3000 w. Can Engr—Aug., 1905. Serial. 1st part. No. 71194.

Spur Gearing. N. A. Carle. Gives diagrams for the rapid calculation of gear variables based on the empirical formula used by Jones and Laughlin for cast-iron gears, with explanation. 700 w. Power —Sept., 1905. No. 71643 C.

Power Plants.

Mechanical Plant of the New York Hippodrome. Illustrates and describes a remarkable plant for producing theatrical effects for amusement purposes. Both electrical and mechanical means are utilized. Also for lighting, heating and artificial cooling. 5000 w. Eng Rec—Aug. 26, 1905. No. 71617.

Modern Power Plant Design and Economics. Franz Koester. The second article discusses the steam generating portion of the plant, including coal and ash handling, water supply, mechanical draft, etc. 5000 w. Engineering Magazine—Sept., 1905. No. 71655 B.

The Power Plant of the United Shoe Machinery Co. Howard S. Knowlton. Illustrated detailed description of the power plant of these shops at Beverly, Mass. 4300 w. Eng Rec—Aug. 19, 1905. No. 71438.

STEAM ENGINEERING.

Boiler Design.

Legal Complications Over Boiler Design. Reprint of a decision rendered in the Supreme Court of Errors of Connecticut which shows in an interesting way the relations between engineer and supply man. 2000 w. Eng Rec—Aug. 5, 1905. No. 71238.

Boilers.

Recent Installations of Niclausse Boilers (Neuere Kesselanlagen mit Niclausse Kesseln). Carl Züblin. A general review of recent naval vessels equipped with Niclausse water-tube boilers, with details of installations. Serial. Part I. 1800 w. Schiffbau—July 12, 1905. No. 71591 D.

Water Tube Locomotive Boiler (Chaudière de Locomotive à Tubes d'Eau). F. Barbier. Illustrated description of the Robert water-tube boiler as fitted to engines of the Algerian railways. 1800 w. 1 plate. Génie Civil—July 29, 1905. No. 71518 D.

Condensation.

Condensing Plant Design. Illustrates and describes the design of a surface plant. 2500 w. Prac Engr—Aug. 11, 1905. No. 71451 A.

Counterbalancing.

Counterbalancing an Oscillating Engine. Explains the peculiarities in the design of the Case engine, and the experimental work done in investigating the subject of counterbalancing. Ills. 1200 w. Mach, N. Y.—Aug., 1905. No. 71143 C.

Draught.

Artificial Draught for Boiler Plants. F. H. Davies. Discusses briefly the systems of mechanical draught and their operation. 2000 w. Elec Engr, Lond—Aug. 11, 1905. No. 71454 A.

Engines.

Design and Construction of Steam Engines. Reviews the development briefly, and the improvements of the last 150 years in the present number. 1800 w. Mech Engr—Aug. 19, 1905. Serial. 1st part. No. 71625 A.

Double Tandem Reversing Engine with Improved Valve Gear (Zwillings Tandem Reversiermachine mit Neuer Steuerung). W. Schnell. A heavy rolling mill engine with piston valves and Allan straight link, the link being reversed by hydraulic power. 800 w. 1 plate. Stahl u Eisen—Aug. 1, 1905. No. 71582 D.

18,000 Horse Power Rolling Mill Engines. Two-page plate, illustrations and description of a vertical rolling-mill engine recently constructed, intended to drive the heaviest class of rolls, and to be very economical in steam. 900 w. Engng—Aug. 18, 1905. No. 71635 A.

Modern British High-Speed Steam Engines. Leo H. Jackson. Gives description of the standing and running parts of a typical engine, considering deviations made by different makers. 4500 w. Cassier's Mag—Aug., 1905. Serial. 1st part. No. 71383 B.

Links in the History of the Steam Engine. Gives particulars of some old prints recently found at the British Museum. Illustrations, with reprint of "A Description of the Engine for Raising Water by Fire," with remarks. 4000 w. Engr, Lond—Aug. 11, 1905. No. 71466 A.

600-Horse Power Carels Compound-Condensing Engine. Illustrated description of an engine shown at the Liége Exhibition. 1500 w. Engng—Aug. 11, 1905. No. 71463 A.

The Atlas Four-Valve Engine. Illustrated description of a new type of four-valve engine of medium size. 1500 w. Engr, U S A—Aug. 15, 1905. No. 71422 C. 71422 C.

The Boujour Engine. Illustrates and describes a 75-horse power condensing engine shown at the Liége Exhibition. 2000 w. Engr, Lond—July 28, 1905. No. 71257 A.

The Engines of the Interborough Station. Illustrated detailed description of the horizontal vertical twin compound Allis-Chalmers engines in the N. Y. Subway power house. 2500 w. Power—Sept., 1905. No. 71641 C.

The "Hoyois" Steam Engine. Illustrates and describes a single-cylinder engine exhibited at the Liége Exhibition. 500 w. Engng—July 21, 1905. No. 71162 A.

Feed Water.

Feed-Water Heaters. Ernest R. Briggs. Discusses the commercial economy effected by the feed-water heater, and considers the regenerative system. Ills. 3400 w. Engr, Lond—July 28, 1905. No. 71256 A.

Governor.

The Nordberg Static Governor. Illustrated description of a governor for pumping engines and air compressors which introduces the new principle of controlling the speed through a wide range by a centrifugal governor. 900 w. Am Mach—Vol. 28, No. 34. No. 71491.

Heat Engines.

Substitutes for Steam. Compares water and bisulphid of carbon, following them through their respective cycles and showing how the amounts of heat supplied compare with the results obtained. Ills. 3500 w. Power—Sept., 1905. No. 71642 C.

Priming.

The Measurement of the Water Entraining Steam (Mesure de la Quantité d'Eau Entrainée par la Vapeur des Générateurs). M. Emanaud. Describing especially the Brocq apparatus and also the method of dissolving salt in the water. 2500 w. Génie Civil—Aug. 12, 1905. No. 71522 D.

Pumping Engine.

See Mechanical Engineering, Hydraulics.

Receivers.

Something About Receivers. W. H. Wakeman. Considers points in piping receivers of steam plants. Ills. 1200 w. Power—Sept., 1905. No. 71644 C.

Reducing Motions.

A Differential Reducing Motion. D. L. Gallup. Illustrated description of an accurate device for obtaining correct indicator diagrams. 300 w. Engr. U. S. A.—Aug. 1, 1905. No. 71232 C.

Smoke Prevention.

Smokeless Combustion and Economy of Fuel. William Mayner. Illustrates and describes the mechanical stoker and smoke consumer invented by Charles Wegener, a German engineer. 1800 w. Sci Am Sup—Aug. 26, 1905. No. 71488.

See Civil Engineering, Municipal.

Steam Pumps.

Steam Pumps and Their Failures. M. Powis Bale. Considers some of the principal causes of pumps failing. 2000 w. Prac Engr—Aug. 4, 1905. No. 71351 A.

Stuffing Box.

A Double Stuffing Box (Doppellagerabdichtung). Hr. Toussaint. Illustrating a form of stuffing box especially adapted for maintaining a tight joint about revolving shafts, as propeller shafts, or the spindles of steam turbines or centrifugal pumps. 1200 w. Zeitschr d Ver Deutscher Ing—Aug. 12, 1905. No. 71514 D.

Superheating.

Tests of a Superheating System with Utilization of Waste Gases (Untersuchung einer Dampfkraftanlage mit Zweifacher Ueberhitzung durch Abgase). E. Josse. Data and results of tests upon the Wolf semi-portable tandem compound engine, using superheated steam. Two articles, 5000 w. Zeitschr d Ver Deutscher Ing. July 15, 22, 1905. No. 71504 each D.

Tests.

One Hundred Steam Engine Tests (Ein Hundert Dampfverbrauchsversuche). J. Krumper. A tabulated discussion of economy tests upon a large number of steam engines of various types, built by the United Augsburg and Nürnberg Works. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 12, 1905. No. 71511 D.

Tube Cleaners.

Misuse of Boiler Tube Cleaners. A. S. Atkinson. Discusses some of the causes of trouble and the ruin wrought by incompetent workmen, and the question of the kind of power used to operate the cleaners. 1800 w. Boiler Maker—Aug., 1905. No. 71236.

Valve Gears.

The Selection of Eccentrics for Double Valve Gears (Die Wahl der Exzenter bei Doppelschiebersteuerungen). W. Pickersgill. With valve diagrams showing the influence of variations in eccentricity upon valve action in slide-valve engines. 2000 w. Zeitschr d Ver Deutscher Ing—July 8, 1905. No. 71501 D.

Valves.

Emergency Valves. W. H. Wakeman. Illustrated descriptions of emergency valves for use with high pressure steam, explaining their applications. 1000 w. Elec, N. Y.—Aug. 2, 1905. Serial. 1st part. No. 71144.

Low Pressure Slide Valve with Triple Openings for Admission and Exhaust (Niederdruckschieber mit Dreifacher Eröffnung für Einlass und Auslass und mit Ueberströmung). M. Hochwald. The valve is a combination of the Penn double-ported valve and the Allen valve with auxiliary passage, giving quick and large opening with small travel. 1200 w. Zeitschr d Ver Deutscher Ing—Aug. 12, 1905. No. 71513 D.

Steam Turbines.

Determinations of the Efficiency and Steam Consumption of Steam Turbines (Beiträge zur Bestimmung des Wirkungsgrades und Dampfverbrauches von Dampfturbinen). H. Anders. With numerous tabulated results of tests of Parsons turbines driving electrical generators. 6000 w. Glückauf—July 15, 1905. No. 71541 D.

The Steam Turbine as Applied to Electrical Engineering. Charles A. Parsons, G. Gerald Stoney and C. P. Martin. Read before the Inst. of Elec. Engrs. Gives the history of the development of the steam turbine as applied to electrical engineering, explaining details, and giving results obtained. 4000 w. Sci Am Sup—Aug. 12, 1905. No. 71284.

MISCELLANY.

Earthenware.

Machinery made of Earthenware (Maschinen aus Steinzeug). Georg Lindner. Describing plunger and centrifugal pumps, blowers, and other machines made of glazed earthenware to resist the action of acids and other corrosive fluids. 5000 w. Zeitscher d Ver Deutscher Ing —Aug. 12, 1905. No. 71510 D.

MINING AND METALLURGY

COAL AND COKE.

British Columbia.

The Nicola-Coldwater Coal Beds. Horace F. Evans. A description of the geology of this valley in British Columbia. 2500 w. Min Wld—Aug. 19, 1905. No. 71416.

By-Products.

By-Product Coke Ovens in Westphalia (Zur Frage der Nebenproduktgewinnung beim Kokereibetriebe in Westfalen). W. Fritz. Describing the construction of the Otto coke ovens in the Westphalia district, and the recovery of sulphate of ammonia as a by-product. Serial. Part I. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 5, 1905. No. 71552 D.

Cannel Coal.

Cannel Coal in the United States. George H. Ashley. Considers the causes of failures of cannel coal, the importance of investigating the appearance, analysis, thickness, extent of the beds, and discusses the uses for which it is adapted. 3800 w. Min Wld—July 29, 1905. Serial. 1st part. No. 71122.

Coal District.

Map of the Zwickau Coal District (Uebersichts Karte des Zwickauer Steinkohlenreviers). J. Treptow. General description of the district, with map showing the location of the collieries. 1800 w. 1 plate. Glückauf—Aug. 5, 1905. No. 71548 D.

Coke.

The Beginnings of Coke Manufacture (Die Anfange der Koksfabrikation). Oscar Simmersbach. An historical review, with sketches of early coke ovens used in Germany and England. 4000 w. Glückauf—July 8, 1905. No. 71540 D.

Maryland.

Ocean No. 7, or "Klondike" Mine of the Consolidation Coal Company in the Georges Creek Region, Maryland. J. J. Rutledge. Illustrated description of the mine and its workings. 4500 w. Mines & Min—Aug., 1905. No. 71201 C.

Newfoundland.

Newfoundland Coal. Information concerning the valuable deposits. 1400 w. Col Guard—Aug. 11, 1905. No. 71459 A.

New Mexico.

New Coal Developments in Northern New Mexico. Emerson W. Judd. Illustrates and describes the property and the arrangements to increase the output. 1200 w. Eng & Min Jour—Aug. 19, 1905. No. 71430.

Peat.

Peat in Florida. J. M. Cheney. Illustrates and describes a plant for the manufacture of peat briquets, giving information in regard to their use, cost, etc. 1500 w. Engr, U. S. A.—Aug. 15, 1905. No. 71421 C.

Production.

The Production of Coal in 1904. Edward W. Parker. From the Mineral Resources of the United States. Gives statistics and a review of the conditions. 4400 w. Min Wld—Aug. 19, 1905. No. 71415.

Queensland.

Queensland Anthracite Coal. R. J. Cottell. Information concerning this industry in Central Queensland, giving an analysis of the coal, and the results obtained with it. 1800 w. Aust Min Stand—July 12, 1905. No. 71495 B.

Queensland Coal Mines. Reports of mine inspectors in regard to the trade, production, coalfields, etc. Plate. Ills. 5000 w. Queens Gov Min Jour—June 15, 1905. No. 71173 B.

Silesia.

Present Knowledge of the Hard Coal District of Upper Silesia (Der Heutige Stand unserer Kenntnisse über das Oberschlesische Steinkohlengebirge). H. Geisenheimer. A detailed account of important coal deposits lying between the Prussian, Russian and Austrian frontiers, with map and sections. 5000 w. 2 plates. Glückauf—July 22, 1905. No. 71543 D.

Wyoming.

The Coal of the Black Hills, Wyoming. N. H. Darton. Describes the deposits and reports the extent to which they have been worked. 2800 w. Min Wld—Aug. 5, 1905. No. 71197.

COPPER.

Electro-Metallurgy.

See Electrical Engineering, Electrochemistry.

Trans-Caucasus.

The Copper Industry of the Trans-Caucasus. Gives the more important deposits so far investigated. The information is from a recent Russian report. 700 w. Engng—Aug. 4, 1905. No. 71362 A.

Treatment.

New Methods in the Metallurgical Treatment of Copper Ores. N. S. Keith. Describes a method for the utilization of low-grade copper ores. 3500 w. Jour Fr Inst—Aug., 1905. No. 71295 D.

The Treatment of Copper Rock at the Quincy Mills, Hubbell, Mich. C. K. Hitchcock, Jr. Describes the rock, and the method of treatment used, which aims to reduce, as far as practicable, the loss in the tailings. Plate. 2500 w. Sch of Mines Qr—July, 1905. No. 71297 D.

GOLD AND SILVER.

Alaska.

Gravel and Placer Mining in Alaska. Custer Wells Purington. Explains the methods of mining made necessary by the unusual conditions, giving information in regard to the cost. Map. 4000 w. Min Wld—July 29, 1905. No. 71123.

Amalgamation.

Amalgamating Tables. Algernon Del Mar. Gives sketches of three styles of tables, discussing the important essentials. 900 w. Min & Sci Pr—Aug. 5, 1905. No. 71322.

A New Device for Amalgamating Gold in Sands and Pulps. Illustrates and describes a device invented by Patrick McEntee for treating gold-bearing sands, stamp mill pulp, and other material. 1200 w. Min Rept—Aug. 24, 1905. No. 71607.

California.

The Ancient Channel of Gibsonville, Cal. Samuel C. Wiel. Describes these channels and the old methods of mining, the character of the gravels, and the general conditions. Ills. 1800 w. Min & Sci Pr—July 29, 1905. No. 71195.

Clean-Up.

The Use of Bisulphate of Sodium in the Clean-Up. Jas. E. Thomas and Gerard W. Williams. Reports a series of experiments and the results. 2500 w. Jour. Chem, Met & Min Soc of S Africa—June, 1905. No. 71345 E.

Comstock.

The Comstock Lode. Don Maguire. Description and history of the discovery and development of one of the richest ore deposits ever mined. Ill. 6000 w. Mines & Min—Aug., 1905. No. 71200 C.

Cupellation.

Cupellation and Parting. Herbert R. Edmonds. Considers the shape of cupels and the material, referring to paper by Dr. Kirke Rose. 1000 w. Eng & Min Jour—Aug. 12, 1905. No. 71305.

Cyanide.

Gold Extraction by Cyanide: a Retrospect. John S. MacArthur. States the circumstances which led to the invention of the cyanide process. 1800 w. Eng & Min Jour—Aug. 12, 1905. No. 71308.

Precious Metals Recovered by Cyanide Processes. Charles E. Munroe. From the *Census Bulletin.* Reviews the history of the cyanide process, giving information from various sources showing the varieties of methods. 4000 w. Sci Am Sup—Aug. 5, 1905. Serial. 1st part. No. 71190.

Dredging.

Gold Dredging in California. A. G. Hillen. An illustrated article giving information in regard to the extent of this method of working, the cost, &c. Map. 2500 w. Min Wld—Aug. 5, 1905. No. 71196.

Gold Dredging in California. Information from the Bul. of the State Min. Bureau of Cal., giving the history of dredge mining in the state, the area of dredge gravel, &c., in the present number. Ills. 2800 w. Min & Sci Pr—Aug. 19, 1905. Serial. 1st part. No. 71610.

Free Gold.

Free Gold in Veins. Arthur Lakes. Gives instances which in the writer's opinion prove that gold may exist free, in free solutions, in veins or other rocks and be deposited in a crystalline, free or native state. 1200 w. Min Wld—July 29, 1905. No. 71124.

Hydraulic Mining.

Hydraulic Mining with Centrifugal Pumps. Enos Brown. Illustrates and describes a successful plant installed at Grant's Pass, Oregon, where there are acres of rich placers which have never been extensively worked. 1100 w. Sci Am—Aug. 19, 1905. No. 71388.

India.

Milling in India. Robert F. J. Weeks. A brief account of metallurgical operations (milling) at the Champion Reef Gold Mining Co. of India, Ltd. 2400 w. Mines & Min—Aug., 1905. No. 71204 C.

New South Wales.

Mount Boppy (N. S. W.). J. B. Jaquet. The Chief Inspector of Mines report on this goldfield, describing its geology and reporting concerning the development. Ills. 1800 w. Aust Min Stand—July 12, 1905. No. 71496 B.

Placers.

Placer Mining in Alaska. C. W. Purington. Abstract from the Bulletin of the U. S. Geol. Survey, describing the methods of mining. Ills. 1800 w. Min & Sci Pr—Aug. 12, 1905. Serial. 1st part. No. 71425.

Placers.

Placer Mining in Siberia. Abstract translation from *L'Industrie Aurifere.* M. D. Levat. Describes some of the difficulties, the methods of work, and the prospecting. 1500 w. Min Wld—Aug. 26, 1905. No. 71604.

Queensland.

Black Ridge, Clermont. Lionel C. Ball. Preliminary report of the geological survey, giving location, geology, deposits and general information of the auriferous ground. Ills. 10000 w. Queens Gov Min Jour—June 15, 1905. Serial. 1st part. No. 71172 B.

Tailings.

Saving Coarse Gold from Tailings After Direct Cyaniding by Means of an Agitator. Paul J. Johnson. Detailed description of the writer's method of using an agitator and the results. Ill. 1200 w. Min Rept—July 27, 1905. No. 71113.

Some Suggestions on the Cyaniding of the Tailings. Prof. A. Prister. Describes a proposed working method which the writer considers worth a serious discussion. 2000 w. Jour Chem, Met, & Min Soc of S Africa—June, 1905. No. 71346 E.

Transvaal.

The Transvaal Gold Mines. Theodore F. Van Wagenen. Begins a review of this industry in the Transvaal. 1700 w. Min & Sci Pr—Aug. 19, 1905. Serial. 1st part. No. 71608.

Water Recovery.

An Experience in Water Recovery. George S. Binckley. Describes the method of recovery at Congress, Arizona, giving illustrations. Also the design of a recovery plant where there was a very limited flow of water, and the working of the system. 3900 w. Min & Sci Pr—Aug. 19, 1905. No. 71609.

Yukon.

The Yukon Territory. An address delivered by Dr. R. W. Raymond at the farewell banquet given to the visiting party of the Am. Inst. of Min. Engrs. at Dawson, Y. T. 1800 w. Eng & Min Jour—Aug. 12, 1905. No. 71308.

IRON AND STEEL.

Blast Furnaces.

Blast Furnace Gas Blowers. Dr. Alfred Gradenwitz. Illustrates and briefly describes examples of gas-driven blowers made in Germany. 600 w. Ir Trd Rev—Aug. 17, 1905. No. 71396.

Blow Holes.

A Study of the Causes of Blow Holes in a Steel Block (Untersuchung über den Ursprung eines Blasenraumes in einem Flusseisenblocke). Dr. H. Wedding. With micro-photographs showing the internal structure of the fractured metal, and data of chemical and physical examinations. 2500 w. Stahl u Eisen—July 15, 1905. No. 71580 D.

Castings.

See Mechanical Engineering, Machine Works and Foundries.

Electric Smelting.

See Electrical Engineering, Electro-Chemistry.

Furnaces.

Britain's Earliest Iron Furnaces and Moulding Floors. Thomas May. An illustrated article describing remains of smelting, refining, moulding and other furnaces investigated during recent excavations, and showing the Roman methods of iron manufacture. 7500 w. Ir & Coal Trds Rev—Aug. 11, 1905. No. 71468 A.

Gate Valve.

A Large Gate Valve of New Type for Low Pressures. John J. Smith. Illustrates and describes valves designed for blast-furnace work. 1500 w. Am Mach—Vol. 28, No. 34. No. 71492.

Iron.

See Mechanical Engineering, Materials.

Live Rolls.

Notes on Live Conveying Rolls for Structural-Shape Rolling Mills (Einiges über Warmlager und Adjustagen Schwerer Profileisenstrassen). Bruno Quast. Discussing methods for increasing the carrying capacity of the conveying rolls for rail and similar mills. 2000 w. Stahl u Eisen—Aug. 15, 1905. No 71586 D.

Luxembourg.

The Development of the Iron Industry of Luxembourg Since 1879 (Der Werdegang der Eisenindustrie Luxemburgs seit 1879). Gustav Loose. A review of the iron industry of Luxembourg and its commercial relations to the markets of France and Germany. 3500 w. Stahl u Eisen—July 15, 1905. No. 71579 D.

Oil Furnaces.

Care, Use and Design of Oil Furnaces. Stephen Uren. Discusses questions of the economy of oil as compared with coal, the effect on the material, and the latest improvements in furnace doors, fire brick, burners, etc. Ills. 2300 w. Pro Pacific C Ry Club—July 15, 1905. No. 71291 C.

Open-Hearth.

The Bertrand-Thiel Process. E. von Moltitz. A detailed description of this process, giving results and stating its advantages. 5000 w. Ir Age—Aug. 10, 1905. No. 71245.

Piping.

A Process for the Prevention of Piping in Large Steel Ingots (Verfahren zur Verhütung der Lunkerbildung in Schweren Rohstahlblocken). F. O. Beikirch. Describing the use of a sinking head which is afterwards cut off, removing the piped portion. 1800 w. Stahl u Eisen—Aug. 1, 1905. No. 71581 D.

Methods for the Prevention of Piping in Steel Blocks (Die Verfahren zur Verhütung der Lunkerbildung in Stahlblocken). R. M. Daelen. Describing fluid-compression methods, also methods of heating the molds, and the author's continuous process. 1800 w. Stahl u Eisen—Aug. 15, 1905. No. 71585 D.

Statistics.

The Iron Industry in the Year 1904 (Das Eisenhüttenwesen im Jahre 1904). Dr. B. Neumann. A review of the output of the principal iron-producing countries of the world, discussing the conditions from a German point of view. 7500 w. Glückauf—July 29, 1905. No. 71546 D.

Steel.

See Mechanical Engineering, Materials.

Sulphur.

The Presence of Coke Sulphur in the Blast Furnace (Das Verhalten des Koksschwefels im Hochofen). Oscar Simmersbach. An examination of extent to which sulphur may be brought into the blast furnace with the fuel; with tabulated results of analyses. 2000 w. Glückauf—July 15, 1905. No. 71542 D.

Texas.

The Iron Industry of Texas, Present and Prospective. Edwin C. Eckel. Gives information concerning the commercial and engineering phases of the Texas iron industry. 3000 w. Ir Age—Aug. 24, 1905. No. 71474.

Titanium.

Influence of Titanium on Pig Iron and Steel. P. Delville. Read before the Min. & Met. Cong. at Liège. Gives information concerning the smelting of titaniferous ores, and the little known of the effect of titanium on iron and steel. 1200 w. Mech Engr—Aug 5, 1905. No. 71353 A.

MINING.

Deep Leads.

Charlotte Plains Deep Leads. E. J. Dunn. Describes deep alluvial mining, showing gold wash deposits. 1200 w. Aust Min Stand—July 5, 1905. No. 71247 B.

Diamond Drills.

The Diamond Drill in Missouri. R. D. O. Johnson. Describes the method of drilling in southeastern Missouri, and the great deposits of lead ore discovered and worked. 2000 w. Eng & Min Jour—Aug. 12, 1905. No. 71304.

Drainage.

The Sumps of the Lower Workings of the Barza Gold Mine near Brad in the Siebenbürgen District (Das Sumpfen der unter Wasser Tiefbau der Goldgrube Barza bei Brad in Siebenbürgen). H. Wendeborn. Describing the use of electrically-driven centrifugal pumps for shaft sinking in water bearing strata. 3000 w. Glückauf—July 22, 1905. No. 71544 D.

Dust.

Apparatus for Laying Dust in Coal-Mines. J. Cresswell-Roscamp. Abstract of a paper in Trans. Inst. of Min. Engrs., 1905. Illustrates and describes an improved watering car, and the treatment of coal-dust. 900 w. Eng & Min Jour—Aug. 26, 1905. No. 71601.

Electric Power.

Application of Electricity to Mines. A. C. Anderson. Abstract of a paper read before the British Inst. of Elec. Engrs. Considers the choice of a system, the voltage, distribution, motors, &c., and the applications to pumping, winding and haulage, coal-cutters, drilling, &c. 4800 w. Elec Rev, N Y—Aug. 19, 1905. No. 71433.

Explosives Testing.

The Testing of Explosives for Coal Mines. Illustrated description of the British Home Office testing station at Woolwich, and of stations on the Continent, with accounts of methods. Also editorial. 5500 w. Ir & Coal Trds Rev—Aug. 18, 1905. No. 71653 A.

Faults.

Fault Phenomena. A. Lakes. Illustrated description of examples of Colorado faults both old and recent, with a few practical suggestions for miners. 800 w. Min Rept—Aug. 17, 1905. No. 71424.

Fire Damp.

Protection Against Fire Damp. Describes the instrument called a methanometer, recently installed in a large colliery in Pennsylvania, and its successful working. 1400 w. Sci Am—Aug. 5, 1905. No. 71183.

Hoisting.

Hoisting Practice in the Pennsylvania Anthracite Region. R. V. Norris. With numerous illustrations of winding engines, cages, head works and details of the best modern practice of the Pennsylvania anthracite district. 3500 w. Engineering Magazine—September, 1905. No. 71659 B.

Prevention of Hoisting Accidents. A. Selwyn-Brown. Discusses the need of daily inspection of hoisting ropes, the wear, strains, and devices for diminishing strains, giving advice for the care of such ropes. Ills. 1300 w. Eng & Min Jour—Aug. 26, 1905. No. 71602.

Hoisting Ropes.

Dangerous Conditions as to Length and Number of Broken Wires in Mine Hoisting Ropes (Unsichere Drahtlänge, Gefährdete Seillänge und Zulässige Anzahl der Drahtbrüche bei für Mannsfahrten noch Verwendbaren Seilen). Hermann Kroen. Discussing principles governing the inspection of hoisting cables. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 12, 1905. No. 71553 D.

Hydraulic Mining.

Hydraulic Mining Conditions in the Atlin District of British Columbia. Extract from the report of the Provincial Mineralogist. Describes the present conditions, the progress, and the character of the deposits. 1500 w. Min Rept—July 27, 1905. No. 71114.

Jig.

The Hancock Jig at Penn Wyoming Co.'s Mill. R. B. Lamb. Illustration, with brief description of a very successful machine installed at Encampment, Wyoming. 1000 w. Min & Sci Pr—Aug. 12, 1905. No. 71426.

Nova Scotia.

Metalliferous Mining in Nova Scotia as Compared with Mining in Other Countries. J. Owen James. A discussion of the mining laws, mining prospects, operations, &c. Ills. 6500 w. Ind Adv—Aug., 1905. No. 71448.

Ore Deposits.

Igneous Rocks in Ore Deposition. A. Lakes. Discusses some peculiarities of ore deposition, showing that all igneous rocks are not necessarily ore generators. 1500 w. Eng & Min Jour—Aug. 5, 1905. No. 71229.

Ore Treatment.

Mixed Sulphide Ore Treatment. W. R. Ingalls. From *The Mineral Industry*, Vol. XIII. Remarks on the treatment of these ores in the Joplin district, at Creede, Colo., and in Wisconsin and other places. 1500 w. Eng & Min Jour—Aug. 19, 1905. No. 71427.

Powder Thawing.

An Underground Magazine and an Electric Powder Thawer. William Kelly. Abstract of a paper in Pro. of the L. Superior Min. Inst. Gives an illustrated description of a central underground magazine, and an electric powder thawer. 1200 w. Eng & Min Jour—Aug. 19, 1905. No. 71429.

Roasting.

Air in Roasting. William E. Greenawalt. Gives results of tests made to determine the effects of time and air on roasting and extraction, with remarks. 1000 w. Eng & Min Jour—Aug. 19, 1905. No. 71428.

Latest Achievement in Roasting Furnaces for Quicksilver and Other Ores. Illustrates and describes the Dennis roasting furnace, giving information concerning it, and discussing its valuable features. 1500 w. Min Rept—Aug. 17, 1905. No. 71423.

Safety Lamp.

Tests of the Wolf Acetylene Safety Lamp (Versuche mit der Wolfschen Azetylen Sicherheitslampe). H. Beyling. The lamp contains a charge of carbide to which water is gradually fed; safety being attained by enclosing the flame in glass and wire gauze. 4000 w. Glückauf—July 8, 1905. No. 71539 D.

Shafts.

Misplacement of Mining Shafts and Adits. Stanley Hunter. Abstract of paper in Trans. Aust. Inst. Min. Eng. Vol. X. Gives typical examples showing waste due to mistakes in methods. Ills. 1600 w. Eng & Min Jour—Aug. 12, 1905. No. 71306.

Smelting.

The Smelter-Fume Problem. A. W. Warwick. Remarks on changes due to the consolidation of the smelting plants under one management, particularly discussing the damage from smelter-fumes, showing that it is not nearly as great as alleged, and not easy to solve. Ills. 3300 w. Min Mag—Aug., 1905. No. 71288 C.

Timbering.

Timbering and Arching in Mines. Idris Thomas. Read before the South Wales Inst. of Engrs. An illustrated description of the methods adopted in every-day labor in South Wales coal mines, where some of the finest examples of timbering may be found. 5500 w. Ir & Coal Trds Rev—July 21, 1905. No. 71171 A.

Ventilation.

A Successful Fan Test. J. T. Beard. Illustrated account of a successful test of a mine-ventilating fan at North Wilkes-Barre, Pa. 1000 w. Eng & Min Jour—Aug. 5, 1905. No. 71228.

Tests of a Capell Ventilator at the Dorstfeld Mines (Untersuchung eines Capell-Ventilators auf Zeche Dorstfeld II-III). Data and results of tests of a ventilating fan delivering 8,000 cubic metres of air, in actual service. 1200 w. Glückauf—July 29, 1905. No. 71545 D.

See Mechanical Engineering, Measurement.

MISCELLANY.

Amber.

Amber in Santo Domingo. Clarence C. Sample. Describes the island and the amber-bearing section, the rocks, and the varieties of amber. 1600 w. Eng & Min Jour—Aug. 12, 1905. No. 71307.

Congress.

The Congress of Metallurgy (Congrès de la Métallurgie). Léon Guillet. A general report of the metallurgical congress held at Liége in connection with the international exposition. Two articles. 6000 w. Génie Civil—Aug. 5, 12, 1905. No. 71520 each D.

Emeralds.

Emerald Mines in Colombia. From a report by Mr. Lloyd-Owen, describing the celebrated emerald mines of Muzo, Colombia. 1300 w. Min Wld—Aug. 26, 1905. No. 71605.

Fluorspar.

Principal American Fluorspar Deposits. H. Foster Bain. Information concerning the Kentucky-Illinois fluorspar district, explaining the uses and value of the different grades. 2000 w. Min Mag—Aug., 1905. No. 71290 C.

Incrustation.

Examination of Incrustation Formed on Rabble Plate of a McDougall Furnace. William P. Headden. Read before the Colorado Sci. Soc. Describes the appearance and gives the analyses made. 1500 w. Min Rept—Aug. 3, 1905. No. 71198.

Petroleum.

The Petroleum Industry of Germany (Die Erdöl Industrie Deutschlands). H. Plock. A general review of the production in Europe, and an account of the refining and manufacturing of lubricants in Germany. 7500 w. Glasers Annalen—Aug. 1, 1905. No. 71532 D.

Phosphate.

Tennessee Phosphate. R. D. O. Johnson. Describes the deposits and methods of mining. Ills. 3500 w. Eng & Min Jour—Aug. 5, 1905. No. 71230.

Salt.

Chamber Workings in Rock Salt Mining (Ueber Bergmühlen im Kalisalzbergbau). H. Kegel. A description of the method of excavating working chambers in the rock-salt mines of the Halle district, with formulas for computing costs. 3000 w. Glückauf—Aug. 5, 1905. No. 71547 D.

Wolfram.

The Wolfram Deposits of New England, New South Wales. Hartwell Conder. Briefly describes this district and the deposits of wolfram, and the occurrence of other valuable minerals. Editorial. Ills. 3000 w. Min Jour—Aug. 12, 1905. No. 71446 A.

Zinc.

Zinc Carbonate Ores of the Magdalena Mountains. Charles R. Keyes. Describes the location, geology, ore deposits, and peculiarities of this region in New Mexico, especially considering the zinc ores. Ills. 2400 w. Min Mag—Aug., 1905. No. 71289 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accident.

The Liverpool-Southport Railway Accident. Brief illustrated account of the accident of July 27, explaining the results of the collision. 700 w. Engr, Lond—Aug. 4, 1905. No. 71371 A.

Canada.

How Canada is Solving Her Transportation Problem. Lawrence J. Burfee. Describes the natural features of Canada, its numerous waterways, and the climatic conditions which lead to the population settling largely in the southern part; explains the recent rapid growth and development, showing the importance of transportation facilities, and giving an account of completed and proposed work. 4500 w. Pop Sci M—Sept., 1905. No. 71470 C.

Engineers.

Essential Qualities of a Successful Locomotive Engineer. W. J. Hill. Considers education, experience and good judgment the most essential. 1600 w. Ry & Engng Rev—Aug. 12, 1905. No. 71325.

Great Britain.

A German Impression of British Railroads. Wilhelm Cauer. An account of the features that impressed a railroad engineer from the Continent, while traveling for instruction. 5000 w. R R Gaz—Vol. XXXIX, No. 7. No. 71402.

Notes on British Railways (Mitteilungen von den Englischen Eisenbahnen). W. Cauer. An address before the German Railway Association discussing British terminals and operative methods from a German viewpoint. 4500 w. 1 plate. Glasers Annalen—Aug. 1, 1905. No. 71531 D.

Operation.

The Operation of an Automatically Blocked Single Track Railroad. H. M. Waite. Brief paper on the successful working of this system on the C. N. O. & T. P. Ry. 2500 w. Pro St Louis Ry Club—Aug. 11, 1905. No. 71639.

Private Cars.

An Apology for the Private Car and a Remedy for Its Abuses. A. M. Simmons. Reviews briefly the history of the private car, the circumstances which led to the building of refrigerator cars, the growth of the industry, the present problem, and a suggestion for its solution. 2500 w. Ry & Engng Rev—July 29, 1905. No. 71112.

Train Logs.

Graphic Train Logs. Paul T. Warner. Eplains the method of preparing these interesting records which show all stops and variations in speed on the run. Gives four curves prepared in the manner indicated. 1000 w. R R Gaz—Vol. XXXIX. No. 5. No. 71227.

MOTIVE POWER AND EQUIPMENT.

Brakes.

The Combined Automatic and Straight-Air Brake. R. H. Blackall. Read before the New England R. R. Club. Describes the operation of these brakes and states their advantages. 3300 w. Ry & Engng Rev—Aug. 12, 1905. No. 71324.

The Control of Fast Trains by Brakes. Editorial discussion of the safety in operation of high-speed trains. 1200 w. Ry Age—Aug. 4, 1905. No. 71217.

Buffer-Coupling.

Thomas's Central Automatic Buffer-Coupling. Description of the apparatus, with drawings. 1200 w. Engng—Aug. 11, 1905. No. 71464 A.

Car Loading.

Machine for Loading Box Cars with Coal. Illustrated description of the tilting cradle, invented by S. Kedzie Smith, and its operation. 1700 w. Eng News—Aug. 3, 1905. No. 71180.

Cars.

Covered Goods Wagons for Japanese Railways. Brief illustrated description of a lot of 900 narrow gauge (3 ft. 3 in.) covered goods wagons being built in Chicago for the Japanese Imperial Government Railways. 400 w. R R Gaz—Vol. XXXIX., No. 7. No. 71399.

Delaware & Hudson Composite Coal Car. Illustrated description of composite hopper gondola cars of 80,000 pounds capacity. 400 w. Ry Age—Aug. 4, 1905. No. 71219.

Steel Freight Car Design. C. A. Seley. From an address at Purdue University. Discusses the design of the steel-frame box car. 1400 w. Am Engr & R R Jour—Aug., 1905. No. 71138 C.

The Building of a Railway Car. Day Allen Willey. Illustrated detailed description of the methods of constructing the coaches used on the principal American railways. 1800 w. Sci Am—Aug. 19, 1905. No. 71392.

Locomotives.

A Handsome Passenger Locomotive of 1861. C. H. Caruthers. Drawing and description of an engine rebuilt when materials vere very high. 700 w. R R Gaz—Vol. XXXIX., No. 8. No. 71612.

An "Atlantic" Compound for the Great Northern of England. Illustrations, with brief description. 350 w. Ry Age—Aug. 11, 1905. No. 71300.

Comparative Tests of Steam and Electric Locomotives. An account of the tests made on the experimental track of the New York Central Railroad, giving results. Ill. 1400 w. Sci Am Sup—Aug. 5, 1905. No. 71186.

Details of Argentine Locomotives. Illustrates compound articulated locomotives (meter gauge) for the Central Northern Railway of the Argentine Republic. The engines work on heavy grades up to 1 in 40 and wood is used as fuel. They have many interesting features. 1600 w. Engng—Aug. 4, 1905. No. 71363 A.

Henri Four-Cylinder Compound Express Locomotives—Paris, Lyons and Mediterranean Railway. F. C. Coleman. Illustration, sections and brief explanation of the Henri system of express locomotives. 400 w. Ry Age—Aug. 18, 1905. No. 71410.

Inspection Locomotives, New York Central Lines. Illustrates and describes a combination locomotive and car found to be very useful. General dimensions are given. 1200 w. Ry & Engng Rev—Aug. 26, 1905. No. 71606.

Locomotives at the Liége Exhibition. H. W. Hanbury. Discusses the Belgian and French locomotives exhibited. 4000 w. Engng—Aug. 18, 1905. Serial. 1st part. No. 71630 A.

New York Central Inspection Locomotive. Illustration, with brief description. 150 w. Ry Age—Aug. 11, 1905. No. 71302.

Schenectady Balanced Compound Locomotive for the Erie. Illustrates and describes tvhis experimental engine built for hauling heavy passenger trains on the grades between Jersey City and Port Jarvis. 600 w. Ry Age—Aug. 4, 1905. No. 71218.

Ten-Wheel Switcher for the Lake Shore. Illustrates and describes the heaviest and most powerful engines yet built for yard service. 700 w. Ry Mas Mech—Aug., 1905. No. 71269.

Tests of Superheater Locomotives by the Belgian State Railways. Extract from a paper by J. B. Flamme, read before the Inst. of Mech. Engrs., giving an account of experiments with locomotives combining superheating with compounding. 700 w. Ry Age—Aug. 4, 1905. No. 71221.

The Development of the Freight Locomotive in America. Charles S. Lake. The present article discusses the types of freight locomotives in use and recent freight engine practice. Ills. 1200 w. Prac Engr—July 28, 1905. Serial. 1st part. No. 71248 A.

Motor Cars.

American Gasoline Railway Motor Cars. Illustrates and describes the Union Pacific's gasoline car, and the gasoline electric car of the St. Joseph Valley Co. 1800 w. Sci Am—Aug. 26, 1905. No. 71484.

The Union Pacific Motor Car No. 1. Illustrated description of a single-truck, four-wheel car, designed for light branch and interurban service. The motive power is a six-cylinder gasoline engine of 100 horse power. 1300 w. Ry Mas Mech—Aug., 1905. No. 71268.

Oil Fuel.

Oil Fuel for Locomotives. Howard

Stillman. Deals with the California deposits, the calorific values, specifications for fuel oil adopted by the Harriman Lines, method of burning, tests made, and related matters of interest. 5000 w. Pro Pacific C Ry Club—July 15, 1905. No. 71292 C.

Speed Tests.

High-Speed Trials with Steam Locomotives (Schnellfahrversuche mit Dampflokomotiven). Data and results of recent trials of steam locomotives upon the Marienfelde-Zossen experimental track. 1800 w. Glasers Annalen—Aug. 1, 1905. No. 71533 D.

Steam Car.

The Peebles Steam Rail-Car. Illustration and description of a new type of steam car for branch line traffic. 1400 w. Tram & Ry Wld—Aug. 10, 1905. No. 71476 B.

Stores.

The Store Department. C. F. Balch. Outlines the needed equipment of a railroad store, considering the facilities, organization and operation. 2000 w. Ry Age—Aug. 4, 1905. No. 71220.

Traverser.

Traverser for the Western Railway of France. Illustrates and describes a new type, designed by M. Dubois, which is light and strong, easy of operation, and designed to transfer rolling-stock from one curved track to another. 1000 w. Engng—July 28, 1905. No. 71252 A.

NEW PROJECTS.

New Line.

The Nile-Red Sea Railway. Map and information concerning the line generally known as the Suakin-Berber Railway. 900 w. Engr, Lond—July 21, 1905. No. 71170 A.

The Northwestern's New Line to Milwaukee. Map and description of a line under construction for relief of the existing lines of the Chicago & Northwestern. 1500 w. R R Gaz—Vol. XXXIX., No. 6. No. 71312.

Rhodesia.

The Rhodesia Railways, Limited. An illustrated description of the railway from Vryburg to the Zambesi and beyond. 2800 w. Eng Rec—Aug. 26, 1905. Serial. 1st part. No. 71616.

PERMANENT WAY AND BUILDINGS.

Location.

Locating a Railroad Line Through a Forest. J. A. Macdonald. Describes the method of getting from one controlling point to another in a rough and difficult forest country. 700 w. R. R. Gaz—Vol. XXXIX., No. 5. No. 71225.

Mountain Railway.

A Unique Colorado Mountain Railway. An interesting description, with map, of this very remarkable railway which reaches an elevation of 10,000 feet. 1200 w. Ry Age—Aug. 18, 1905. No. 71411.

New Plant.

The New Plant of the Louisville & Nashville R. R. Co. at South Louisville, Ky. Illustrated description of a new plant for repair and construction of cars and locomotives, which aimed to have the very best arrangement and equipment for carrying on the work. 5500 w. Engr, U S A—Aug. 1, 1905. No. 71231 C.

Portable Plant.

Electric Plant for Fixing Rails and Packing Permanent Way. Illustrates and describes a portable plant used on some of the French railways for permanent-way construction and repair. 900 w. Engng—Aug. 11, 1905. No. 71462 A.

Quincy Road.

The Quincy Granite Road. S. Harry Ferris, in *Four Track News*. Information of the road, three miles long, built to convery the granite for the Bunker Hill monument, and said to be the first American railroad. Ills. 1100 w. Ry & Loc Engng—Aug., 1905. No. 71136 C.

Rails.

The Creeping of Rails on Railroads. N. Benjamin. Gives an explanation of the creeping which seems to the writer to be the harmony with mechanical laws and supported by experiment. 1900 w. Ry Age—Aug. 4, 1905. No. 71222.

Rail Sections.

Rail Sections as Engineering Structures. P. H. Dudley. Read before the Am. Soc. for Test. Materials. Discusses this subject showing the mportance of the material in the rail, and the problems in the manufacture of rails for present service. Ills. 1500 w. Ir & St Mag—Aug., 1905. No. 71314 D.

Railway Curves.

An Important Problem in Railway Curves. Antonio Llano. Gives a problem of constant occurrence in railroad work, especially in the location of street railway curves, and the solution which the writer considers simpler than those usually seen. 300 w. Eng Rec—Aug. 26, 1905. No. 71618.

Regulations.

English Board of Trade Regulations for Track, Bridge and Signal Work. Gives the requirements governing new construction of railways as relating to signaling, interlocking, passenger stations, bridges, track and switch work. 3000 w. Ry & Engng Rev—Aug. 19, 1905. No. 71414.

Station.

Denver & Rio Grande Station at Grand Junction, Colo. Drawings and description of a somewhat unusual station of pleasing appearance. 350 w. Ry Age—Aug. 25, 1905. No. 71600.

Terminal.

Lackawanna's Eastern Terminal at Hoboken. An illustrated detailed description of the proposed station and ferry house, which will take the place of the recently burned structures. Plate. 2700 w. Ry Age—Aug. 25, 1905. No. 71499.

Workshops.

Northeastern Locomotive Works, Darlington. Illustrates and describes these very large works and their equipment. 1200 w. Engr, Lond—Aug. 18, 1905. No. 71638 A.

TRAFFIC.

Clearance.

Comments on Recent Criticisms of Clearance Proposals. J. W. Midgley. A reply to criticisms on a series of articles by the writer, outlining proposed clearance plans. 4000 w. Ry Age—Aug. 18, 1905. No. 71413.

Demurrage.

Reciprocal Demurrage Laws. Ashley J. Elliott. Speech before the Chamber of Commerce, Decatur, Ill. 3500 w. Pro St Louis Ry Club—Aug. 11, 1905. No. 71640.

Freight.

Handling Fast Freight on the Santa Fe. Information in regard to the system in use on this line for handling high-class and special freight—known as the Red Ball system. 1600 w. R R Gaz—Vol. XXXIX., No. 8. No. 71613.

The Frisco System of Handling Time Freight. An explanation of the present time freight system, giving forms used, and general information. 3000 w. R R Gaz—Vol. XXXIX., No. 7. No. 71401.

MISCELLANY.

Charter.

New Jersey Had the First Railroad Charter in the World. An account of an act passed in the New Jersey legislature, Feb. 6, 1815, creating a company to erect a railroad from the River Delaware to the River Raritan. The road was never built. 1600 w. Ry & Loc Engng—Aug., 1905. No. 71137 C.

Finances.

The Relative Finances of British and American Railways. W. Pollard Digby. Aims to show the relation which the respective railway investments in the United Kingdom and United States bear, both as regards capital and revenue, to the respective populations and external commerce. 4500 w. Engr, Lond—Aug. 11, 1905. No. 71467 A.

Oriental Railways.

Railway Strategy in the Orient. George Ethelbert Walsh. Brief discussion of the importance of railways in the commerce of the Orient, and also for war purposes. 2000 w. Ry Age—Aug. 18, 1905. No. 71412.

Railway Congress.

International Railway Congress. A general review of the seventh International Railway Congress which met in Washington. 1700 w. Engr, Lond—July 21, 1905. Serial. 1st part. No. 71167 A.

STREET AND ELECTRIC RAILWAYS

Accidents.

Accidents and Injuries in Street Railway Operation (Ueber Betriebsstörungen und Unfalle im Strassenbahnverkehr). F. W. Bork. A review of the operation of the street railway system of Berlin, discussing the wear and tear, and the losses and injuries by accidents; with discussion. 3500 w. Glasers Annalen—July 15, 1905. No. 71534 D.

Why Accidents Happen. Dr. H. B. Rockwell. Discusses the main causes of accidents on electric railways. 3500 w. St Ry Jour—Aug., 1905. No. 71207 C.

Bogie Cars.

Four Motors v. Two. Robert N. Tweedy. Notes on tests reported in a recent paper before the Am. Inst. of Elec. Engrs., in New York, with remarks on cost and economy in operation. 2800 w. Elec Rev, Lond—July 21, 1905. No. 71156 A.

Cars.

The Cars of the New York Subway (Die Wagen der New Yorker Untergrundbahn). S. G. Freund. Describing especially the Gibbs steel cars; also the wiring and general electrical arrangements. 6000 w. Elektrotech Zeitschr—Aug. 3, 1905. No. 71561 B.

Control.

The Johnson-Lundell Regenerative Control for Tramcars. Illustrates and describes the latest Johnson-Lundell-

Land regenerative, double series, paralleling, automatic braking control system for electric tramcars. 1800 w. Elec Engr, Lond—Aug. 4, 1905. No. 71355 A.

Draw-Bars.

Some Experiences with Draw-Bars for Electric Cars. W. T. Van Dorn. Gives facts from the writer's experience, showing that it is not wise to use a draw-bar lighter than 3 ins. x 3 ins. stem. Also discusses couplers. Ills. 2700 w. St Ry Jour—Aug. 12, 1905. No. 71299 C.

Freight.

Freight Development by Interurban Roads. E. F. Siexas, in the *Railway and Shipping World*. Gives an account of the success on the Niagara, St. Catharines & Toronto Railway, a steam line originally, but changed to electricity, and concludes that the freight business of interurban lines will pay if confined to the higher class of traffic, and attention is paid to dispatch and accommodation of the public. 2500 w. Ry & Engng Rev—Aug. 12, 1905. No. 71323.

Interurban.

Improvements to a Toledo Road. An illustrated account of the extensive improvements to the system of the Toledo, Bowling Green & Southern Traction Company. 5000 w. St Ry Jour—Aug. 12, 1905. No. 71298 C.

Metropolitan.

Metropolitan District Railway. Illustrated description of some of the rolling stock equipment and traffic arrangements. 3500 w. Tram & Ry Wld—Aug. 10, 1905. No. 71475 B.

New Zealand.

The Installation of Electric Tramways in Christ Church, New Zealand. James Drummond. Illustrated detailed description of a complete electric railway system built under the auspices of the municipality. 2200 w. St Ry Jour—Aug., 1905. No. 71206 C.

Overhead Equipment.

The Prevention of Overhead Accidents. Robert N. Tweedy. Explains how the safety of the overhead equipment is guarded on one of the large Midland systems. 2200 w. Elec Rev, Lond—Aug. 11, 1905. No. 71457 A.

Paris.

The Construction Works of the Paris Metropolitan (Travaux de Construction des Differentes Lignes du Metropolitan de Paris). Georges Lesourd. A very full account of the recent extensions of the Paris underground railway, bringing the record down to January, 1905. 20,000 w. Mem Soc Ing Civ de France—March, 1905. No. 71594 G.

Power Distribution.

The Underground Distribution of Power for Urban Electric Traction. James Heywood. Read before the Philadelphia branch of the Am. Inst. of Elec. Engrs. Discusses the conduits, high-tension cables, terminals, tests, installation, d. c. cables, return cables, localization of faults, etc. Ills. 3300 w. St Ry Jour—Aug. 19, 1905. No. 71408 C.

Rapid Transit.

Philadelphia's Rapid Transit Railroad. Outlines the general scheme for real rapid transit, and begins an illustrated detailed description of the Market Street subway, now under construction. 4800 w. R R Gaz—Vol. XXXIX., No. 7. Serial. 1st part. No. 71400.

Spokane.

Electric Railways in and About Spokane. An illustrated article giving information of interest relating to the lines receiving power from the Washington Water Power Co. 3000 w. St. Ry Rev —Aug. 15, 1905. No. 71398 C.

Statistics.

The Status of Electric Railways in Germany at October 1, 1904 (Zusammenstellung der Elektrischen Bahnen in Deutschland nach dem Stande vom 1. Oktober, 1904). The yearly tabulated review of electric traction develoment in Germany, with editorial comment. 12,000 w. Elektrotech Zeitschr—July 13, 1905. No. 71554 B.

Stray Currents.

See Civil Engineering, Water Supply.

Tracks.

The Development of Special Track Work on Street Railways. Victor Augerer. From a paper read before the Conn. Soc. of Civ. Engrs. & Surv. Considers some of the problems of street railways and the modern methods for special track work, comprising curves, switches, frogs, etc. 5800 w. Eng News—Aug. 3, 1905. No. 71176.

Valtellina.

New Electric Locomotives for the Valtellina Railway. Bela Valatin. An illustrated account of the latest methods employed on this important three-phase line, and the new equipment. 6500 w. St Ry Jour—Aug. 5, 1905. No. 71205 C.

Operating Results of the Valtellina Railway—Peculiarities of the Three-Phase Traction. Eugen Cserhati. Gives a summary of results in operating costs, current consumption, recuperation of energy, energy consumption, fly wheel effect, etc. 3500 w. St Ry Jour—Aug. 26, 1905. No. 71611 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad.des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXX. NOVEMBER, 1905. NO. 2.

THE FIRST YEAR'S PREPARATORY WORK ON THE PANAMA CANAL

By John F. Wallace.

Mr. Wallace's first article, which appeared in our issue for September last, outlined broadly the Canal problem and the mode in which it must be attacked. His second paper, last month, stated concisely the conditions existing on the Isthmus when the Canal Commission took over the property, and described the preliminary work of organization, water supply, sanitation, and other preparations essential to the main attack. Reference to these articles will give the reader a fuller understanding of the one following.

In this, the third of the series, the author presents a most interesting summary of the actual construction work accomplished during the year he remained in charge—the total output, the unit costs under varying conditions, and the bearing which the results have upon the final solution of the question "What type of canal shall we build?" More impressive still is the revelation he makes of the strangling effect of Governmental methods upon constructive enterprise. His arraignment of the "moss-covered traditions of Governmental control"—his revelation of "the so-called free hand, with the rest of the body and limbs tightly bound with red-tape"—his appeal for the application of "ordinary and common-sense methods to the accomplishment of the work"—these will be at once recognized as throwing the much-needed light on the only real difficulties in the execution of the great project. They are a dignified statement of facts for which the world has been waiting. A fuller interpretation of their meaning will be found in our editorial on page 252.—THE EDITORS.

THE Panama isthmus was evidently formed by the same upheaval that created the mountain ranges in the two American continents. The minimum disturbance and upheaval, however, occurred at the Isthmus of Panama. There the elevation of the original pass through Culebra was approximately 300 feet above the sea-level. This pass, however, was so narrow that the slopes of the summit excavation have obliterated it; these slopes extending and cutting into the higher ground on the sides have made the excavation apparently much deeper.

The axis of the Isthmus extends in a general easterly and westerly direction, although trending slightly to the northeast and southwest in the general vicinity of the canal location at Panama.

Winding through the hills and coming down from a northeasterly direction parallel to the summit range to the southeastward, flows the Chagres, until it reaches Gamboa in the vicinity of Obispo, flanked to the northward by a secondary range in which, however, there is a decided break in the vicinity of Bohio. Below Gamboa the Chagres takes an abrupt turn of over 90 degrees, and flowing to the northward, enters the Caribbean sea west of Colon and Limon bay.

A careful study of the geology of the Isthmus has convinced me that at one time a narrow estuary of the sea extended as far inland as Obispo, and that the original mouth of the Chagres river was practically at the head of this estuary, above which point the Chagres possesses all the characteristics of a mountain stream. In the dry seasons it is a limpid stream—a succession of deep pools of water clear as crystal, connected here and there with rapids where the river swiftly flows over gravel bars and through boulders.

While the hills below Gamboa on each side of the river between Obispo and Bohio approach to within a few thousand feet of each other, still the slope of the river is flat as compared with that above Gamboa. Below Bohio the valley gradually widens, and from Gatun the river courses through marsh lands to the sea.

Thorough investigations were made in the vicinity of Colon, which showed that there was no true rock in the harbor above the elevation of fifty feet below the sea-level. The harbor itself is filled with soft material to a great depth, except the coral reef upon which the outer edge of Colon is located, extending up to and slightly beyond the mouth of the canal as located by the French engineers in the vicinity of Cristobal Colon. This coral ledge is only nine to twelve feet in thickness and underlaid by clays and alluvial deposits.

At several points along the line of the canal, various seeming rock formations were encountered, but all were of a sedimentary nature—generally clay formations which could be easily cut with a *machete*—never more than hard compact clays of very fine grain. Above the surface of the water in some places, it had the appearance of wave-washed rock. In some localities a rock of the pudding-stone type or a conglomerate was found, composed of gravel and boulders cemented together; but what was ordinarily known as "bed-rock" was not found to exist near the surface at any point along the Chagres valley between Obispo and Colon.

As the topography of the country was not suitable for dam sites between Gatun and Colon, it was not necessary to take borings for a distance of more than 50 feet below the level of the sea; 40 feet below the sea-level would be the maximum depth of excavation. As a possibility for a dam site had been suggested in the vicinity of Gatun, thorough diamond-drill borings were made in this locality, the result of which showed that no continuous bed-rock existed above the elevation of 200 feet below the sea-level. This does not mean, however, that the lowest point of the bed-rock in this vicinity existed at 200 feet below the sea-level, or that it did not exist at much greater depths at other than those points where borings were taken; but as 200 feet was considered in excess of the practicable depth at which it was advisable to construct a foundation for a dam, it was not considered necessary to go deeper.

Owing to the fact that the report of the first Walker commission was based upon the construction of a dam at Bohio, extraordinary care was taken in the investigation made at that point; not only were the borings taken with a diamond drill, but when what was supposed to be bed-rock was encountered, cores were taken from the rock in some cases to the depth of 25 or 30 feet, in order to determine the nature of the material and the fact that it was the bed-rock beyond doubt. Borings were also taken at intervals as close as 50 feet apart on various lines, in order that the maximum depth of the original geological gorge might be thoroughly ascertained. At this place the lowest point of bed-rock was definitely determined at approximately 167 feet.

The original gorge was found to be filled with a heterogeneous mass of material. While immediately next to the bed-rock there existed a shallow stratification of clay, above was a loose porous deposit of boulders and coarse gravel, interspersed with masses of drift wood and the various forms of detritus usually brought down into an alluvial valley by a mountain stream. The careful tests made showed the material to be freely water-bearing, and more so as the bed-rock was approached—the water being fresh even at the maximum depths.

All of the favorable points in the valley between Bohio and San Pablo were carefully explored, and while the bed-rock showed a tendency to rise further up the river, it was not found at such depths as to warrant the selection of a dam site which would be any more favorable than that at Bohio, considering all of the circumstances connected with the situation.

The borings taken at Gamboa, however, across the valley of the Chagres to the eastward of Obispo, showed the bed-rock to be at sea-level, and the conformation of the topography above the surface at this point, together with the higher elevation of the bed-rock, rendered it an ideal situation for the location of a dam.

The general result of the surveys and examinations between Obispo and Colon tended to the conclusion that bed-rock existed at some unknown depth greater than 200 feet at Gatun, and at depths varying from 167 to 150 feet between Bohio and Buena Vista, gradually rising towards the latter point; and also that the sea evidently originally occupied this valley as far as Obispo, which point at some time was the mouth of the Chagres river. During the ages that have since elapsed, the heavy rains of the tropics feeding the Chagres, and the floods of the river, have been gradually filling up this estuary with the debris washed down from the highlands. Boulders, gravel, and heavier sands were first deposited in the upper part of the original gorge, until it had been partly filled and a new slope established for the water, allowing such a slackening of the current as to permit of a deposit of clays, interspersed with beds of gravel and sand, dependent upon the height and nature of the various floods that occurred. When these waters spread out, however, on the flatter slopes of the lower Chagres, and the current became absolutely deadened by its contact with the sea, the finer clays were deposited.

It is also probable that a gradual subsidence has occurred, and that part of the Chagres valley, which is now below sea-level, was at one time at a higher elevation.

It is not necessary for the purpose of this paper to describe in detail the laborious work necessary on the part of the engineers to acquire the information developing these facts.*

The technical studies of the engineers also determined the unadvisability of the construction of the suggested "Tiger Hill Cut-off."

Mr. Ehle's surveys of the upper Chagres valley developed the possibility of securing a much larger flood lake area by the construction of the Gamboa dam, than was indicated by the original topographical maps, and his investigations also determined the length and possibilities of a tunnel route for diverting the surplus water of the

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*Attention is called, however, to the fact that while various complaints have been made by persons occupying clerical and other positions in Panama and Colon, no complaints were made by the civil engineers, who, in fact, were the only ones that encountered and endured what might be called real hardships and privations. Much credit is due to the various engineers and their staffs mentioned in a preceding article, who conducted these technical investigations and studies.

Chagres, contained behind the Gamboa dam, into the head waters of the Juan Diaz on the Pacific slope; and further, an alternate plan for the diversion of these waters on the Caribbean slope.

On the latter, which was a shorter and less expensive line, a plan of an open cut was evolved, and also such data of a hydraulic nature were obtained as would enable a proper determination to be made of the control of the Chagres river through the construction of the Gamboa dam and works of an incidental nature. Briefly, Mr. Ehle determined the following facts: —

The practicability of the construction of a dam at Gamboa, which, constructed at certain elevations, would give surface areas as shown below: —

200 feet above sea-level, a lake area of approximately 43 sq. miles
170 " " " " " " " " 31 " "
132 " " " " " " " " 15 " "

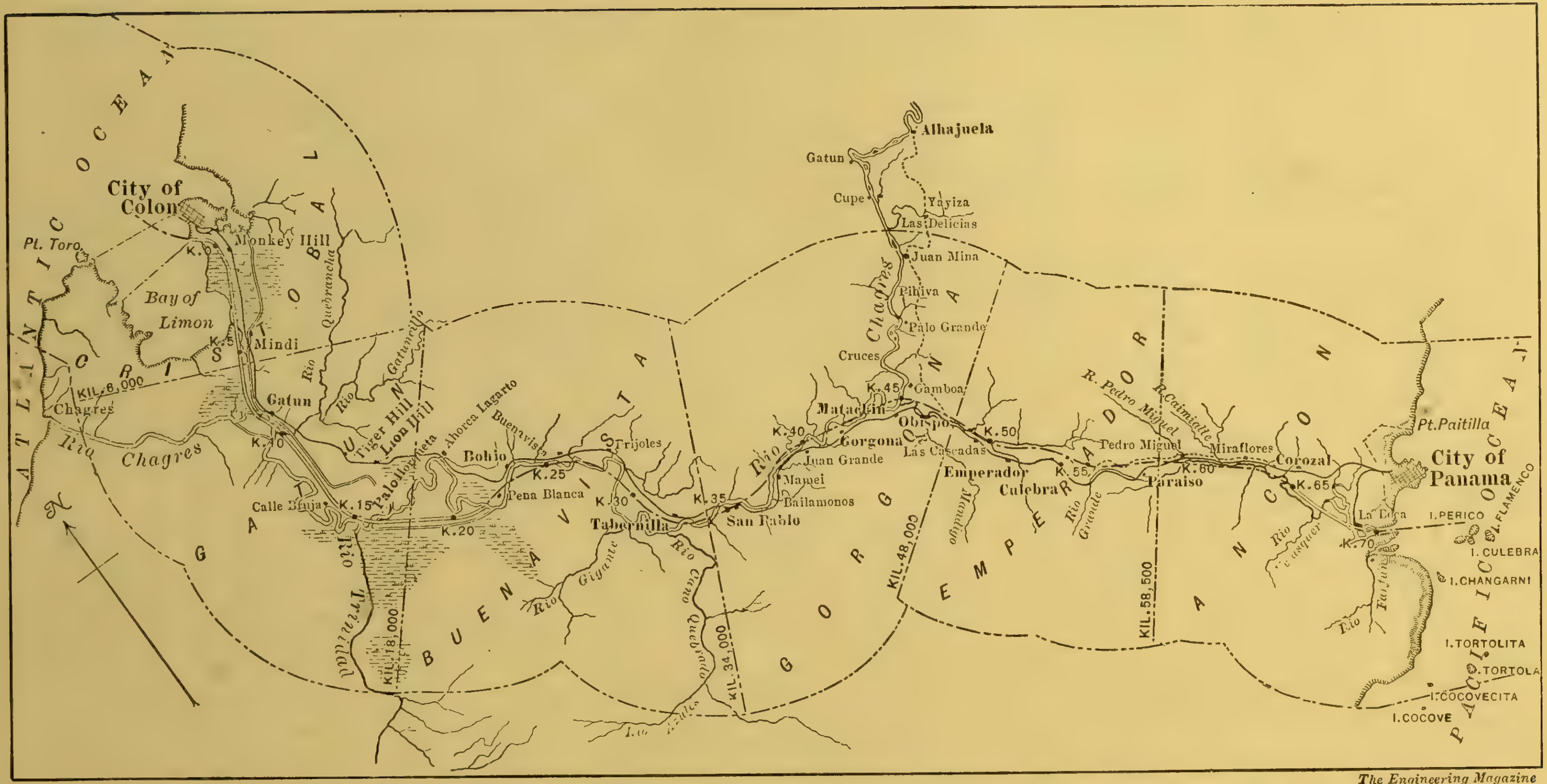
These areas were determined by the estimates based on actual surveys, the bed of the Chagres river being at approximately 50 feet above the sea-level at Gamboa.

The 200-foot contour line was determined by actually running a line at that elevation, around the sides of the valley.

Without going into details of the hydraulic problem, it is sufficient to state that the results of investigations determined the practicability of a dam at Gamboa, creating a lake of sufficient dimensions to control the flood waters of the Chagres river; and also gave the data for determining the question of the control of the average flood of the Chagres, as regulated by the lake created by the construction of this dam, and indicated several methods by which this result could be accomplished; the estimated cost thereof being contained in the official reports, with full details.

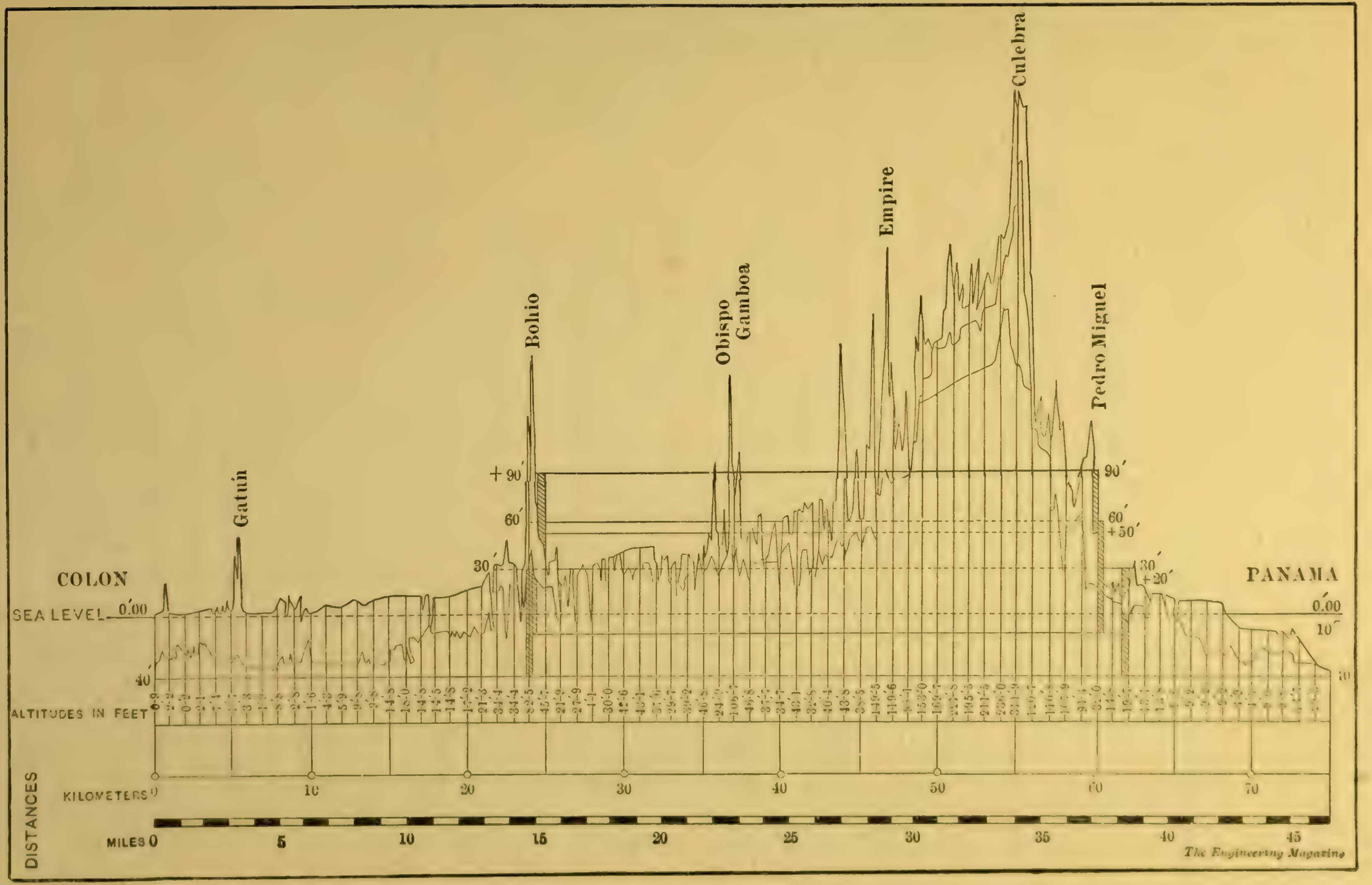
From the data obtained, I can see no reason why it would not be practicable to permit the waters of the Chagres river, as controlled by the Gamboa dam project, to enter and follow the regular canal prism, which would give two outlets to the sea, one in each direction; as the average discharge of the Chagres river through the entire year could be easily taken care of in the canal prism without materially interfering with either the maintenance or operation of the canal, although it might be well to prepare for taking care of a portion of this water through a parallel conduit, which would also intercept the drainage of the hills on the east side of the canal, and act as a diversion channel.

Especial attention is called to the Gamboa dam location for the



The Engineering Magazine

MAP OF THE PANAMA CANAL, SHOWING THE MUNICIPAL DISTRICTS INTO WHICH THE GOVERNMENT OF THE ZONE IS DIVIDED. The elevations of the various points can be readily seen by referring down to the profile on page 167. The top line there shows the original surface of the ground; the second (continuous) line is the excavation made by the first deLesseps company; the third, which appears only through the Culebra divide, indicates the line to which the New French Canal Co. worked. That was the condition when the United States took hold, except that enormous quantities of material had been washed down from the hills and deposited in the sea-level section. The line representing the present surface of the canal bottom in the lower reach, resulting from this filling in, does not appear on this profile.



PROFILE OF THE PANAMA CANAL, SHOWING ORIGINAL SURFACE OF THE GROUND AND THE EXCAVATION DONE BY THE FRENCH.
The reader is referred to the explanatory note under the map on page 166.

reason that it is a necessary adjunct to any plan of a canal which may be decided upon at sea-level, or the summit-level of which may be at any height not exceeding 60 feet, and in which an intermediate navigable lake would not be a necessary feature.

While further detail work should be carried on by the parties in the field to more fully settle questions of minor detail, the essential and basic facts have been secured from the investigations sufficient to enable proper consideration to be given to the general plan.

After the essential facts in relation to the sub-formation of the Chagres valley had been obtained, the diamond-drill parties were assigned to the work of systematic borings along the central line of the canal axis, in order to determine the character of the formation to an elevation of 50 feet below the level of the sea, the first borings being taken about a kilometer apart, these being followed by intermediate borings, which, it was planned, were to continue until the formation was thoroughly explored along and adjacent to the axis of the canal; supplementing and perfecting the system of borings which had been carried on by the French engineers with the same purpose in view. The results thus far obtained indicate great irregularity in the geological formation of the Isthmus.

For a few hundred feet in the Culebra cut, basaltic rock exists. The surface of this rock, however, descends rapidly towards the Pacific and is not continuously found above the line of 40 feet below the sea-level. Northward of the dividing ridge at Culebra the stratification gradually changes to slate, and later to shales and clays; while near Obispo, considerable of the pudding-stone and conglomerate formation is encountered.

Practically no regular stratification exists. Occasionally, perpendicular ledges of hard rock a few feet in thickness form dikes extending at right-angles across the canal axis. While occasional trap, and also lime and sandstone formations, were found at irregular intervals, there is no continuous regular rock formation above a line of 40 feet below the sea-level northward of Culebra, slate formations, shales, clays, sand and gravel forming the greater mass of the material.

During the progress of the surveys in the Chagres valley, a party of topographical engineers under the direction of Mr. Ruggles was at work exploring and carefully mapping the topography of the country between Obispo and Pedro Miguel, covering the section of the canal from the point where it left the valley of the Chagres through the Continental divide, and entered the low-lands of the sea-level section in the valley of the Rio Grande on the Pacific slope. The object of Mr. Ruggles' surveys and investigations was to determine whether or not the French location could be improved upon, and also to ascertain the quantities of material to be excavated in accordance with all of the various plans under consideration.

The investigations of Mr. Ruggles determined the advisability of adhering to the location of the central axis of the canal as adopted by the French.

During the year, the various hydraulic and meteorological observations which had been taken under the French administration were continued, and the compilation and analysis of these results was assigned to Mr. Arango, member of the Am. Soc. C. E., who had charge and was at the head of the bureau controlling this part of the work.

The construction work at Culebra, using the French machinery and organization which was at hand, was continued under the charge of Mr. A. C. Harper, resident engineer, until November, 1904, when the services of Mr. W. E. Dauchy, formerly chief engineer of the Chicago, Rock Island and Pacific system, were secured as division engineer, and the organization both of technical studies and construction, incidental to the excavation through the Continental divide, was placed in his hands. Mr. Dauchy also acted as chief engineer at times when I was absent from the Isthmus.

It goes without saying that a straight and level line is preferable *par excellence* in the location of any line of communication, whether it be a ship canal, railroad, highroad, footpath, or even a telephone or telegraph line. In the construction of any line of communication, a straight and level line is never varied from, except to surmount or get around obstacles; the extent of deviations, vertical and horizontal, being controlled by the questions of time and cost. It is obvious that, other things being equal, the location should follow the line of least resistance as represented by interest on first-cost, plus maintenance and operating charges, and considering the value of time consumed in passage.

The time required to construct should also be considered. In order to determine the comparative merits of any of the various plans, it would seem as a prime requisite that the value of units of accomplishment, both as to time and cost, should be arrived at as accurately as possible. While an assumed value of these units might serve for comparing time and cost of the different plans, I considered it highly advisable, if possible, to secure data from actual work.

As the work of excavation under way by the French could be carried forward without interference with any future plan of work which might be decided upon, it seemed highly important to continue it and demonstrate by actual work, the elements of cost and the efficiency of the various appliances and methods along the following lines to the end:—

First; that the methods used be such as would enable the maximum number of excavating units, of maximum capacity per unit, to be employed.

Second; that in selecting the various appliances, the measure of utility should be the quantity of output and cost per unit.

Third; that no appliances or methods be used which actual experience had not shown to be efficient.

When a thoroughly competent, able, and efficient organization is at work on the Panama Canal, and the work is going forward at the maximum rate of progress possible under all the circumstances surrounding the situation, the larger part of the work will have been accomplished; and the results of the first or second year's work cannot be fairly measured by the yardage of material removed.

This work was carried on during the year and expanded to such an extent as the many difficulties in the way of securing men and material would permit.

The result of the experimental work between May 4, 1904 and January 1, 1905—eight months—was the excavation of 243,472 cubic yards of material, an average of approximately 30,000 cubic yards per month, at an average cost of 55 cents per cubic yard, the output varying from 27,000 cubic yards in May to 43,000 cubic yards in December; maximum cost per cubic yard being 68.6 cents in May and the minimum cost being 50 cents per cubic yard in December. The elements which entered into such costs were those which would necessarily be assumed by any contractor doing the work, and did not include the administrative or engineering expense which would be necessary, whether the work was carried on by contract or hired labor under direction of governmental supervision.

During the next three months, ending March 31, 1905—the dry season—278,680 cubic yards were excavated at an average cost of 45 cents per cubic yard, the maximum output being 133,000 cubic yards in March at a minimum cost of 43 cents per cubic yard. These figures, however, included an arbitrary of 6 cents per cubic yard, to cover the average cost of new plant and installation, this multiplied into the number of cubic yards to be excavated from the central cut being considered sufficient to absorb the entire cost of new plant and equipment needed in the work, and also the rebuilding of such of the old French plant as could be utilized.

The result of the three months work, April, May and June, 1905, however, shows the amount excavated to be 279,589 cubic yards at an average cost of 75 cents per cubic yard.

In order to analyze the result for the last three months it is necessary to consider each by itself. In April the output was 126,750 cubic yards at an average cost of 52.5 cents, the rainfall during this period being 3 inches. In May the output decreased to 76,000 cubic yards, and the cost increased to 84 cents, the rainfall being 13 inches, an increase of 10 inches. In June the output was 77,000 cubic yards, cost $1.03 per cubic yard, and the rainfall was 7 inches.

The increase in cost in May and more particularly in June was due to the combination of many causes culminating in June. The establishment of the eight-hour day and general increase in compensation, the unbalanced condition of the forces due to the difficulty in obtaining men promptly in the proportion needed for the different parts of the work, the necessity of providing men for future requirements, aggravated by the constant leaving of employes discouraged with existing conditions—but more particularly due to the fact that labor and material was not furnished in sufficient quantities to carry out the preparatory work necessary to be performed during the dry season, December to April, in order that the work might be economically and efficiently conducted and carried forward during the wet months of the balance of the year.

This, of course, was aggravated by the fact that the French engines, cars, tracks, and appliances, were not satisfactory for the efficient conduct of the work. The long and ridged wheel base of the French and Belgian engines, in combination with the short track rail of high section, together with the necessity of operating over poorly ballasted tracks, caused an extremely large number of derailments, preventing the proper supply of empty cars to the various steam-shovels and their removal when loaded; consequently the steam-shovels were operated at one-half of their practical ordinary capacity —less than one-fourth of their theoretical efficiency.

With proper auxiliary machinery and appliances, and with sufficient suitable track facilities in connection with the American steam-shovels, the amount of output would have been limited only by the number of steam-shovels at work, multiplied by their full practical capacity, which would naturally have resulted in a largely increased output and a reduction in the cost, even as compared with the result obtained during January, February, March, and April.

It is not to be expected that more favorable results will be obtained, either in quantity or cost, until the next dry season, as compared with the results of the three months ending June 30, 1905, unless the expansion and building up of the construction departments be discontinued and the work carried forward on a small scale, retaining the more experienced men and working only those steam-shovels which are served by track systems in the best condition, using such of the engine and car equipment as is best adapted to the work.

However, the cost per cubic yard during the next few months is mainly important to determine the experimental value of the various elements affecting the work. It may be interesting to note here that the total output for the fiscal year ending June 30, 1905, was 741,644 cubic yards at an average cost of 58.6 cents.

Under the direction of division engineer Maltby, into whose charge were given the sea-level sections of the canal and the harbors at Colon and La Boca, French dredging plants were overhauled and put into commission to enable such dredging to be done as would permit access to be maintained to the wharfs at La Boca on the Pacific end, and Cristobal Colon on the Caribbean end of the canal. These two plants developed a working capacity each of approximately 2,500 cubic yards per day, at a cost of less than 10 cents per cubic yard.

Plans were made for increased wharf facilities at both Cristobal Colon and La Boca, the execution of which, however, was delayed by the non-receipt of proper material.

Time and space will not permit of a detailed description of the large amount of preparatory work carried on under the various bureaus and sub-departments, particularly in the mechanical and machinery department, overhauling the French machinery; the planning and arranging for the construction of new shops and the installation of machinery, for the rebuilding of French engines, cars and other equipment; and the general work of maintaining and repairing plant during the future progress of the work.

Over-conservatism on my part may have induced me to overestimate the value of results obtained from actual practice, but it was considered that if a record of the cost of every function of the work were properly recorded and tabulated, the data obtained therefrom would be valuable in making estimates for the consideration of general plans, and in the determination of various questions which would arise during the progress of the work, as to the relative efficiency of the machinery, appliances, organization, methods, and men.

The system of daily and monthly cost-sheets with explanatory reports put into effect, was such as to give the fullest possible information as to the efficiency and progress of the work. The cost of each function and all the details subordinate thereto were tabulated.

Comparative costs of operation of each excavator and steam-shovel were shown separately—also the cost of excavation and removal of various classes of material; cost of operating different dumps; operating over each separate system of tracks, and the different distances; cost of work performed by different groups of men, all based on the unit cost per cubic yard. In the transportation work the cubic yard moved one mile—practically equivalent to the ton-mile—was the unit considered.

The perfection and extension of this system of unit cost was designed to enable a careful analysis to be made of the relative efficiency as above stated, and would not only give the chief engineer in control the knowledge necessary to supervise properly the work in general, but would also tend to create a spirit of emulation among the different branches of organization and the individuals composing them. Its proper use and application should have a material effect in reducing costs and expediting the work.

The day is gone by when the efficiency of organization, machinery, appliances, methods, and men can be determined simply from general observation. In works of great magnitude, the system of exact records and a scientific analysis of results based on some comparative units of efficiency should be adopted.

As cost and time will be the determining elements in the consideration of final plans, the lower the unit of cost and the greater the amount of output per unit of time, the more efficient the result; and it is to be presumed that if the best form of a canal can be constructed within a reasonable length of time and within a certain limit of cost, the American people would desire its adoption; but on the other hand, there is perchance a limit of cost and time beyond which the American people would not desire to go, even to secure the Panama Canal.

While requisitions were made for a large amount of American machinery, tools, appliances, material, and also the necessary labor to render these available, the lack of information furnished the engineers on the Isthmus as to when requisitions would be filled, or whether they would be filled at all, in whole or in part; the irregularity and slowness of shipments; and the failure to furnish all of such articles as were needed to co-ordinate properly any of the functions of the work, practically rendered ineffectual the efforts of the chief engineer and his construction staff to make satisfactory progress.

Prior to and during the early part of the dry season, when the maximum men and material should have been furnished, neither were supplied in sufficient or properly related quantities.

The efforts of the Commission at Washington were evidently so hampered by the legal requirements controlling the purchase of supplies and the disbursement of Government funds, that—regardless of the individual ability or inclination of the separate members—results seemed impossible of accomplishment. The situation was still further aggravated by the fact that the Commission seemed unduly apprehensive of possible newspaper criticism, or of Congressional investigation, and either consciously or unconsciously permitted this feature to retard prompt action, although the individual members seemed each and all inspired with an earnest desire that the work should satisfactorily progress.

The difficulty in the way of securing material and labor promptly prevented the installation of any American steam-shovels before the latter part of 1904, so that it was not until January, 1905, that an appreciable advantage was derived from their introduction. While the chief engineer used his utmost endeavor to secure the equipment of the work with modern American appliances, steam-shovels comprised practically the only American machinery available during the year ending June 30, 1905.

As the result obtained during the rainy season, which extends from May to December, will always depend upon the work accomplished during the dry season, it should not be expected that immediate benefits so far as actual construction accomplishment would result from the reorganization of the commission in the month of April, 1905; and its functions will necessarily be confined to the determination of plans, organization, methods, and the securing of necessary labor, material and supplies, so that preparation may be fully made to take the utmost advantage of the next dry season.

The experience of the past year will have been wasted unless the controlling authorities at Washington are able to break away from the moss-covered traditions of Governmental control, applying ordinary and common-sense methods to the accomplishment of the work, and Congress shall enact legislation enabling this to be done.

The so-called "free hand"—with the rest of the body and limbs tightly bound with red-tape—can perform but limited functions.

It is not within the province of this article to go into details, but it should be plainly evident that Governmental methods which require from ten to twelve years to complete a structure such as the Federal building in Chicago—which, under private individual ownership and control could have been erected in the space of a single year, at most two—cannot be applied to the construction of the Panama Canal with satisfactory results, if the present generation is to derive benefit from its accomplishment, and at reasonable cost.

A WEST AFRICAN RAILWAY; THE SIERRA LEONE LINE.

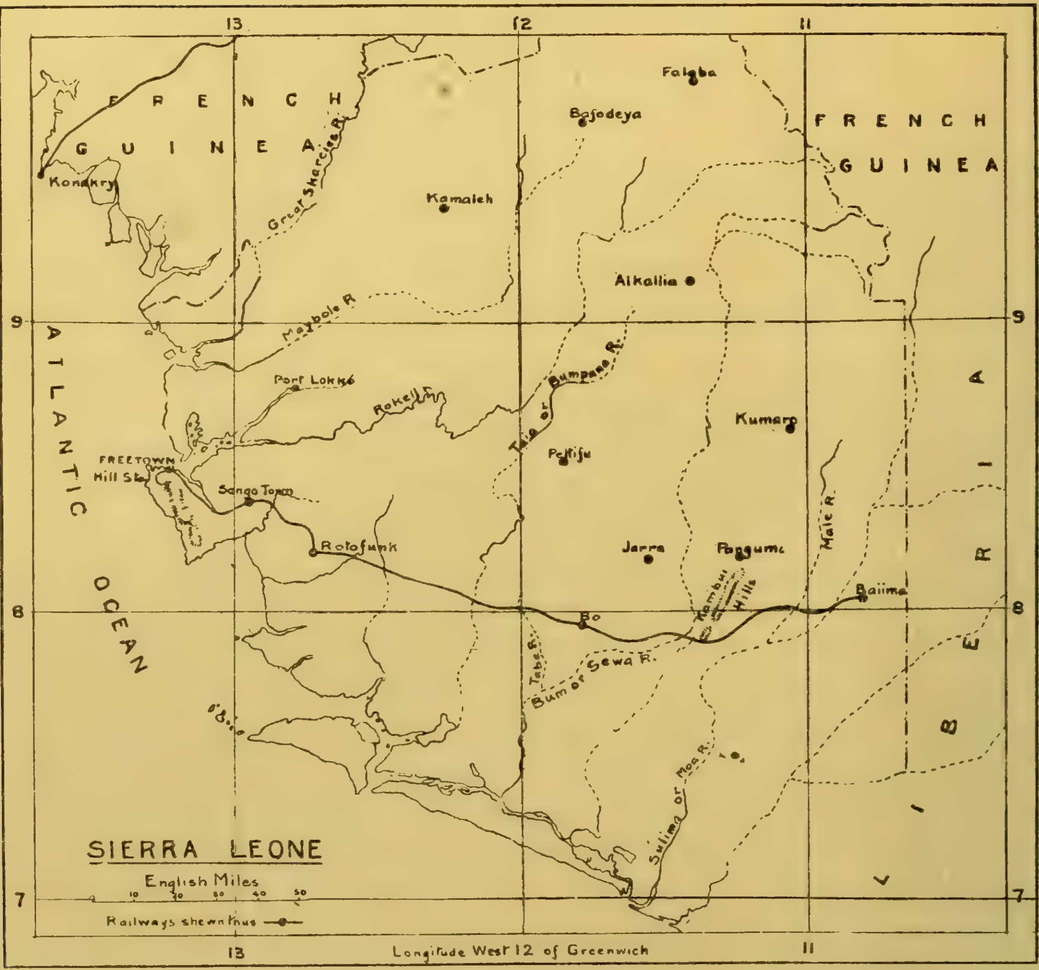
By J. Hartley Knight.

The pioneer project described by Mr. Knight in this number may be interestingly compared with the vast scheme for a Continental African railway which was his topic last month. The Sierra Leone line is one of the pathways by which commerce is penetrating toward the interior of Africa from the West Coast, and the story of its building throws some interesting side lights on the influence exerted on the future of the region and upon its inhabitants.—THE EDITORS.

THE Cape-to-Cairo Railway project, which I had the pleasure of reviewing in a recent issue of THE ENGINEERING MAGAZINE, has seized upon the imagination of the world, not only as the bold conception of a remarkable mind, but as an example of Great Britain's courage and enterprise in opening the Dark Continent to civilization and commerce. When we come to the West Coast, however, we find England no longer leading the van in matters of railway construction; France, in especial, is there far in advance of her.

The reason is not far to seek—France and Germany encourage the construction of railways by means of substantial grants to the promoters thereof, whereas the Imperial Government of Great Britain apparently acts on the principle of letting the railways build themselves. All things considered it is, however, greatly to the credit of a few far-sighted men like Mr. Frederic Shelford, the associate of Sir Benjamin Baker, that British West Africa is able to make so good a show as she does to-day in the matter of railway development. Given the same facilities as her neighbours, there is not the smallest doubt but that British West Africa would long ago have been an "easy first" instead of a "second best" in this direction, and instead of a total mileage of less than 600 miles for the combined colonies under the Union Jack, the whole of British West Africa would to-day be able to boast a network of railways—for as regards rate of construction, at least, in that part of the world, there is abundant proof that the British engineer is able to hold his own.

Of the 600 miles of British-built railways, 222 miles have just been completed in the colony of Sierra Leone. As will be seen from



MAP OF SIERRA LEONE RAILWAY LINE AND ADJACENT TERRITORY.

the accompanying map, the line in question—which has the distinction of being the first to be constructed in West Africa—begins at Free Town, one of the finest natural harbours on the African coast, and runs via Rotofunk and Bo, to a place called Baiima, the terminus for the time being, which is within a few miles only of the borders of the negro republic of Liberia. The gauge of the railway is 2 feet 6 inches, and it cost approximately £4,000 per mile to construct. The surveys for the line were begun in 1893, but it was not till three years later that the work of construction was actually put in hand. The work proceeded but slowly, and the first section of 32 miles to Songo took exactly two years to complete. Another section of 23 miles to Rotofunk was finished in 1900, and in the same year construction was commenced to Bo and completed a couple of years later. The extension to Baiima was begun in 1903, and was handed over to the Government on July 31 last. Progress on the final sections of the line was at the rate of four miles per month.

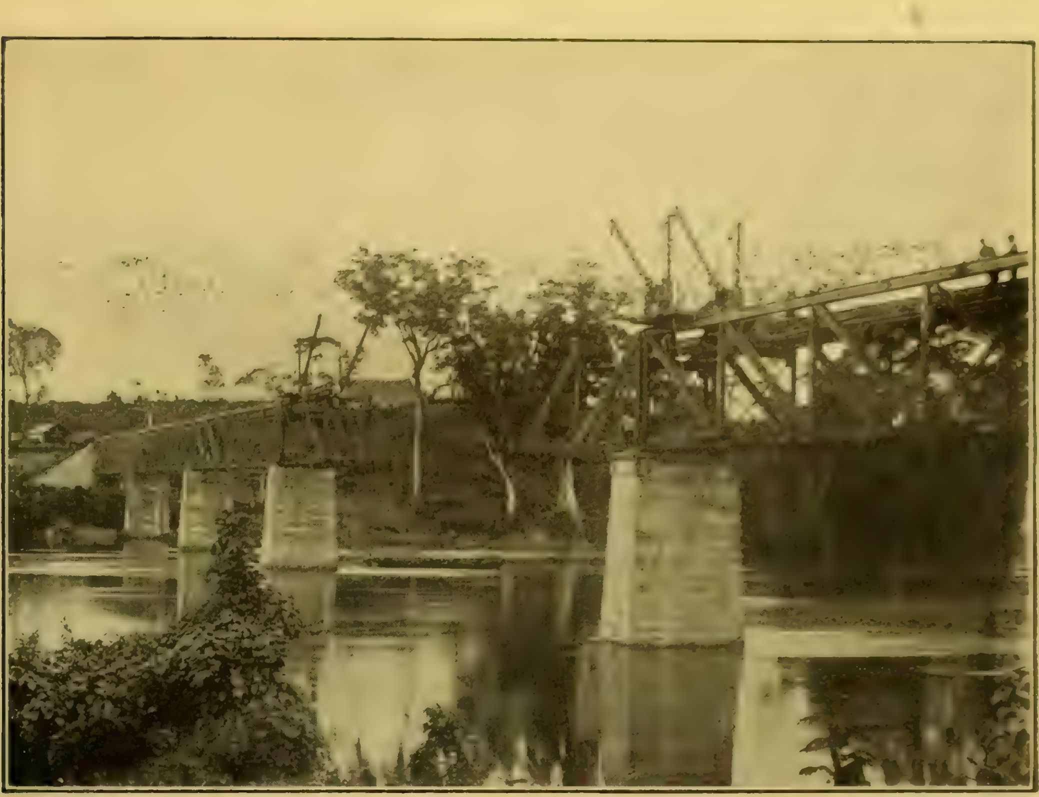
HASTINGS VIADUCT.

The difficulties in the way of the constructors were many and varied. A revolt of the natives in connection with the imposition of a hut tax delayed the advancement of the line for several months, and the engineering strike in England also contributed in some degree to the delay. Sickness of the staff, due chiefly to malaria and the exceptionally heavy rainfall, which not infrequently resulted in floods and wash-outs, likewise helped to retard the work of the engineers. The first part of the route, too, was a difficult one from the engineering point of view; outside Free Town the country was practically unknown ground, and the surveys were in the nature of preliminary reconnaissances following the native paths. Fortunately there was no lack of ballast. In this respect, at least, the Sierra Leone line differs from all others in British West Africa, where ballast during construction was conspicuously absent. Mr. Shelford observed that at Lagos there is a complete absence of hard stone of any kind for nearly 60 miles from the coast, "while though hard rock does exist on the Gold Coast it is as a rule at a depth of from 50 to 100 feet, and the extraction from such quarries of the 500,000 tons of stone required for ballasting the railway was practically impossible. We had to search for surface stones and boulders in the bush, which was at times a useless and always a laborious process."

On the first part of the Sierra Leone line the engineers' skill was somewhat severely tested owing to the exceptionally mountainous character of the district. There are eleven viaducts, most of them being over ravines from 70 to 80 feet deep; and other important works include the Ribbi bridge at mile 39, consisting of three spans of 90 feet and six of 60 feet supported on screw piles, and the Taia bridge and the Sewa bridge, which have a length of 589 and 718 feet respectively. The Moa bridge at mile 213 has eight spans and a length of 660 feet.

Thereafter the construction was comparatively easy, and no large earthworks have been found necessary, the line following the contour of the ground except where by so doing it would be unduly lengthened. The maximum height of banks and the deepest cuttings probably do not exceed 20 feet. Between Free Town and Rotofunk the maximum gradient used is 1 in 60 on the main line, and the sharpest curve is five chains, or 330 feet. The rails are flat-bottomed and rest on steel sleepers, timber sleepers being out of the question owing to the ravages of the white ant. The average booked speed on the railway, including stoppages, is 14 miles per hour, but this is frequently exceeded.

WELLINGTON VIADUCT, SIERRA LEONE RAILWAY.



SEWA RIVER BRIDGE IN COURSE OF CONSTRUCTION.

The locomotives all have six coupled wheels, and the larger engines have in addition a pony wheel in front and one behind. All the locomotives are fitted with a double roof to protect the driver from the sun. The first-class carriages are comfortably furnished with cane seats and a sloping back of the same material. Entrance to the coaches is obtained at either end. With the exception of some two or three brake vans for local work, the whole of the stock is mounted on bogies. The present rolling stock consists of 22 locomotives, 45 carriages, and 110 wagons, and the greater part of the stock is maintained and housed at the main depôt at Clive Town, a couple of miles from Water Street station.

The railway works have been constructed chiefly by natives under the supervision of Europeans. At first some difficulty was experienced in training the natives to this class of work, as the average West African villager is entirely unaccustomed to anything but agricultural employment in its crudest form. By dint of wonderful patience, however, the supervisors gradually educated the natives to what was required of them, and today, thanks to this training, many of the natives hold positions as carpenters, fitters, plate-layers and station-masters. In this connection the builders of the line are making some

AN UP-COUNTRY STATION ON THE SIERRA LEONE RAILWAY.

very interesting experiments. They have arranged for some West African natives to serve their time as apprentices in locomotive workshops in England, "and thus far," to quote Mr. Shelford again, "their progress and behaviour have been excellent. The only question is whether when they get back to Africa they will not be altogether too superior and allow vanity to interfere with their usefulness."

The Sierra Leone Mountain Railway is a special feature of the trunk line, and is an inestimable boon to the white inhabitants, for whose convenience, after much vexatious delay, it was constructed. It runs from Free Town to a plateau 1,100 feet above the level of the sea, and in the opinion of Mr. A. Arkell-Hardwick, author of "An Ivory Trader in North Kenia," it offers an "ideal site for a residential suburb," commanding as it does "a most extensive view, both over the Atlantic Ocean and the surrounding country, and is fully exposed to the health-giving sea breezes." For the first mile and a half the line passes through the streets of Freetown. The nature of the ground does not permit of an ascent being made until the line has crossed the Congo Stream two miles from Water Street station. The Congo Stream is spanned by a viaduct of five spans, having a length of 240 feet and a height above ground of 50 feet. The line then commences the ascent by an average gradient of 1 in 30 until the hill terminus is reached at 5¾ miles. In many places the grade is as much as 1 in 23, one of the heavy grades having a length of a quarter of a mile. At present, I understand, there are no signals, but the trains are worked by the electric staff, the points and crossings being worked by hand from a lever alongside the track.

Although the Sierra Leone Railway has only recently been opened for its entire length of 222 miles, yet the various sections as they were built were opened as soon as completed by the construction department. The section from Free Town to Songo has now been in operation for nearly six years; traffic is developing, and before long it is confidently expected that the line will be paying interest on the cost of construction, as well as working expenses, which are already being met. The Government Railway has not been regarded in itself as a purely remunerative undertaking, but rather, I am informed, "in connection with the development of trade and prospects of the colony." The population on the latter portion of the line is known to be large, and the railway now taps the palm forest of the southwest district. Palm kernels form at present by far the largest export of Sierra Leone, the annual value being about £250,000. Much is also expected from the cultivation of cotton, although for the time being the export of this particular commodity is practically *nil*.

MODERN POWER-PLANT DESIGN AND ECONOMICS.

By Franz Koester

IV. THE ELECTRICAL EQUIPMENT OF THE GENERATING ROOM.

Mr. Koester's series began in August last, with an analysis of the general design and construction of the central station and its adaptation to its environment and its contained machinery. His second article dealt with the steam-generating plant and accessories. His third, last month, took up the discussion of the prime movers—both reciprocating and turbine types—and their relative efficiency. The following pages conclude the subject with a summary of the best practice in installing the electrical equipment. The author's practical familiarity with the most recent work which has been done on the Continent and in the United States (for he has been intimately associated with the leading designers on both sides of the Atlantic) makes his papers especially interesting and valuable.—THE EDITORS.

ECONOMY in the electrical equipment of the generator room is not of such paramount importance as reliability of service, the former depending more directly upon the water and coal consumption in the power plant, while break-downs are much more frequent in the electrical equipment. During the last few years the voltage at the bus bars has been considerably increased, introducing many complications on the switch-board as well as in each individual piece of apparatus. Where originally ordinary hand-operated knife switches sufficed, now oil-insulated automatically operated switches are required. The measuring apparatus are interconnected by means of step-down transformers, and the bus bars as well as the oil switches are carefully located in fireproof compartments.

It is not within the scope of this article to describe the main generators selected for power and lighting stations, nor to detail the individual electric apparatus, but rather to cover the general electric equipment in modern power-plant installations.

As previously pointed out, modern practice tends toward the general adoption of electric-driven auxiliaries, viz., water and air pumps, exciter sets, etc. Individual electric-motor drive for the machinery of the boiler house, such as coal and ash-handling apparatus, stokers, draught fans and economizers, scrapers, etc., has long been recognized to be the best practice. Their low first cost and cost of maintenance, the little attention required for operation, and the cleanliness as well as several other advantages of electric driving will probably in the near future be recognized even by those power-plant designers who yet cling tenaciously to the steam-driven auxiliaries. To engineers fearing a break-down in the electric equipment it may be said that almost similar danger exists in connection with the mechanical equipment. In both cases provision must be made to reduce the liability of failure to a minimum, and also to cut out any defective section easily. The relatively higher efficiency of the electric-drive system may be easily comprehended when it is pointed out that a 7,500 horse-power unit may operate with a steam consumption of some 10 to 15 pounds per horse-power hour, while a 75-horse-power pump consumes some 50 or 60 pounds, or even more—about four times that and more of the large unit, while the transmission losses from the generators are comparatively small. By eliminating the steam-driven auxiliaries, of course, additional current must be furnished either from the main generator unit or from a steam-driven auxiliary generator. The exciter may be driven direct from the main generator, either by gearing or belting, or where high-speed prime-movers (such as turbines) are adopted, it is considered good practice in Europe to mount the exciter directly on the main shaft.

When the individual motor-drive system is adopted, a storage battery should always be installed to supply power in case of a break-down (the cause of which may be either inside the plant itself or outside on the line) unless the auxiliary generator is steam-driven and the current kept an entirely distinct system from the main line. Besides this, the presence of a storage battery in the power house is also invaluable in case of severe short circuit when it is always ready to take the load of exciting the main generator or lighting the power house. The battery is also desirable during a heavy load for maintaining a steady voltage on the exciter bus bars. As the storage battery is often employed for the operation of the automatic switches, it might as well be installed of sufficient capacity to supply power in case of emergency.

A similar system will be installed in the most modern Continental plant—the St. Ouen plant of Paris, the normal output of which will be 20,000 kilowatts—and as all the auxiliaries will be operated by electric motors, a storage battery of 1,300 ampere-hours will be installed. In addition to operating the pumps, this will also furnish exciting current in case of emergency. For the ordinary excitation of the four 5,000-kilowatt turbo-generators, one 300-kilowatt turbo-generator of 200 volts and 2,700 revolutions will be installed. In addition to this there will be two motor-generator sets of 375 kilowatts each operating in multiple with the above battery.

At the new plant for the Interborough Rapid Transit Company of New York, five 250-kilowatt generators are installed to supply exciting current and to operate motor-driven auxiliaries such as coal-handling apparatus, stokers, etc. The entire auxiliary system other than this—as water and steam pumps—are steam driven. Two of these dynamos are steam-driven, while the others are motor-driven; all of them work in multiple with a storage battery of some 3,000-ampere-hours capacity.

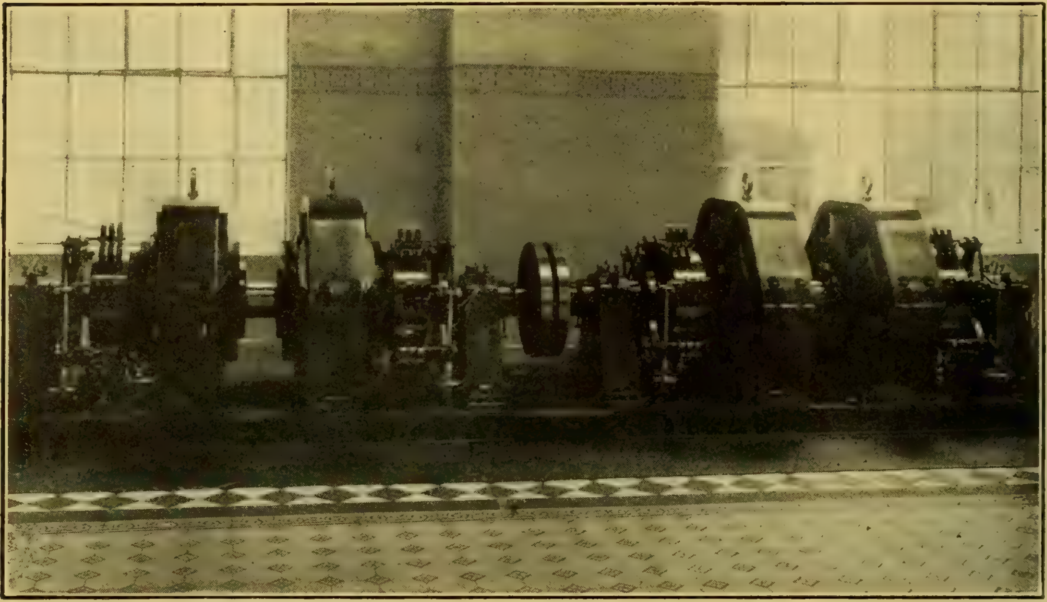


FIG. 70. BOOSTERS IN A HAMBURG CENTRAL STATION.

Although cost of installation and maintenance is great, the storage battery is usually a paying investment—depending of course on the type of service. This may be said not only of large power plants, but of small plants as well. On the continent of Europe one will have difficulty in finding a plant where the storage battery has been omitted. In small industrial towns having their own direct-current central stations furnishing power in the day time, and at the same time charging the battery which furnishes current for lighting at night, the battery is designed so as to be able to supply part of the power at the peak during the day. One of the Hamburg direct-current plants previously mentioned has a total engine capacity of 5,600 kilowatts and a storage battery of 1,250 kilowatt-hours capacity. The booster for this battery is illustrated in Figure 70.

The value of the storage battery may be easily seen from the accompanying chart, representing a load diagram on the San Francisco, Oakland & San Jose Railway Company's power plant, where "chloride accumulators" operate in parallel with the generators on the railroad line. It will be noticed that the minimum current is about 180 amperes, while the maximum is about 2,200. The division of the load between the battery and the generators is also shown in this chart, and the fluctuation of some 1,200 amperes is taken care of by the battery. Although today there are not many who advocate direct-current power plants for long-distance transmission, for railroading or even lighting, the need of a storage battery is still urgent in the central station and in the sub-station when continuous current is employed on the railway motors; but this does not come within the province of this paper.

In large power houses a specially built annex at the side of the generator room, for switching and measuring purposes, is of great convenience, but where space for this is not available, a part of the generating room should be set aside for this purpose only, as it is not good practice to locate the switch-board near the mechanical side of the plant, the high-tension cable and steam pipes (both usually carried under the engine room floor) being too liable to interfere with each other. The end wall of the generating room in a large power plant is seldom large enough to accommodate the entire bus-bar and switching system, and therefore space running at the side of the generating room farthest from the boiler room may be utilized for this purpose. The main bus bars may be located below the floor level of the engine room, but the controlling switches should be placed preferably in the gallery from which the generating room is easily overlooked.

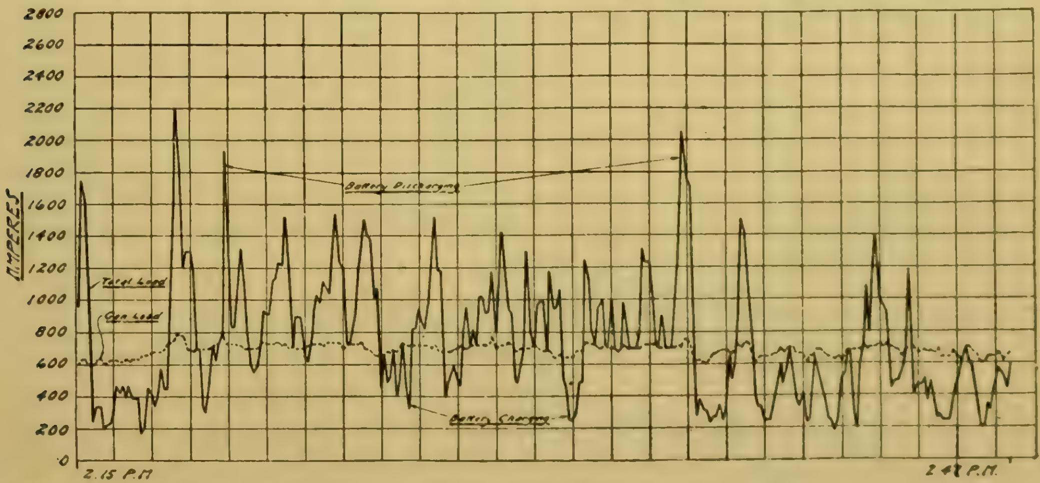


FIG. 71. LOAD DIAGRAM, POWER PLANT OF SAN FRANCISCO, OAKLAND, AND SAN JOSE RAILWAY CO.

A flexible wiring system and a well arranged switch-board are of the greatest importance to insure a steady operation of the power plant; the requirements are similar to those in the steam-pipe equipment. To be too economical in this direction, as in omitting fuses

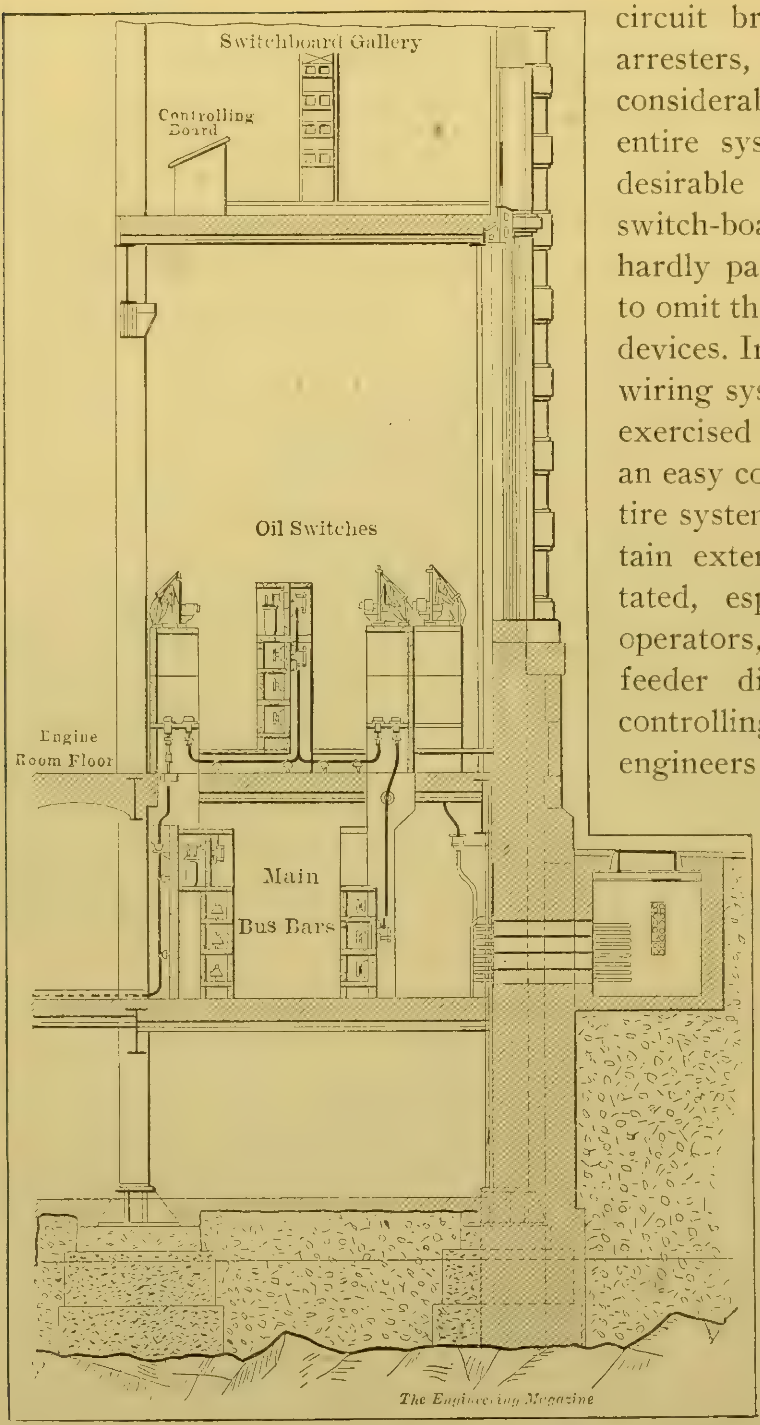


FIG. 72. SECTION OF INTERBOROUGH COMPANY'S POWER HOUSE, 59TH ST., N. Y., SHOWING SWITCHING ARRANGEMENTS.

circuit breakers, lightning arresters, etc., may cause considerable damage to the entire system. It may be desirable to simplify the switch-board, but it will hardly pay or be advisable to omit the necessary safety devices. In complicating the wiring system care must be exercised in order to have an easy control over the entire system, which to a certain extent may be facilitated, especially for new operators, by placing a feeder diagram near the controlling devices. Many engineers are of the opinion that complicated machines or systems are more liable to break down than simple ones, but practice has often proven the contrary, provided a proper design is secured. It is certain, however, that they require a more skilful attendance.

Modern high-tension apparatus is of considerable size and complicated so that it would not be desirable to crowd it behind the switch-board; this is also undesirable on account of the high potential (step-down transformers are located between bus bars and measuring instruments). It is general practice to have this part of the apparatus located in another part of the plant, rather than at the switch-board itself. The feeds from the generators may lead direct to the bus bars, which may run the entire length of the generating room, while the switches are operated from a centrally located board from whence all distant apparatus is easily controlled. The main bus bars (of which two sets are generally desirable) are located on the main generating-room floor, or below it, where the high-tension switches are also located. The bus bars and switches are placed in separate fireproof compartments. The switch-board and controlling board are located above in the gallery, from whence the high-tension switches are operated, either electrically, mechanically or pneumatically. An example of up-to-date American practice is given in Figure 72, showing sectional views of the New York Interborough Rapid Transit Company's Subway power house. It will be noticed that the main bus bars are placed in the gallery beneath the main generator-room floor, while the oil switches are located in a gallery above. While the bus bars run the entire length of the building, the switchboards occupy only a small space. A diagram showing the main bus bars and group switch arrangements is given in Figure 75. The complete wiring system, which will be seen in Figure 74, explains itself. Another wiring system, that of one of the twin municipal plants of Vienna is shown in

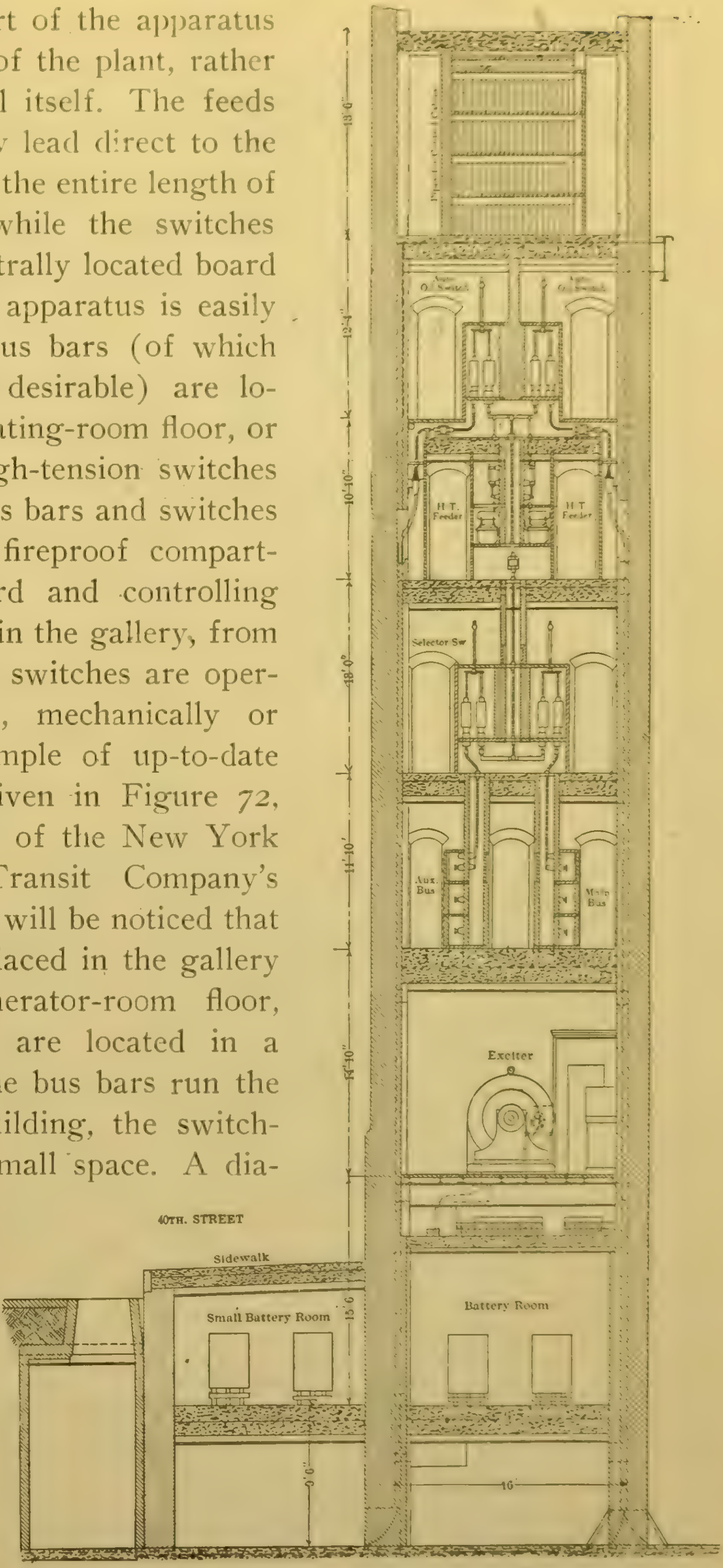


FIG. 73. TYPICAL MODERN HIGH-TENSION (10,000-VOLT) SWITCHING ARRANGEMENT, WATERSIDE POWER PLANT, N. Y. EDISON CO.

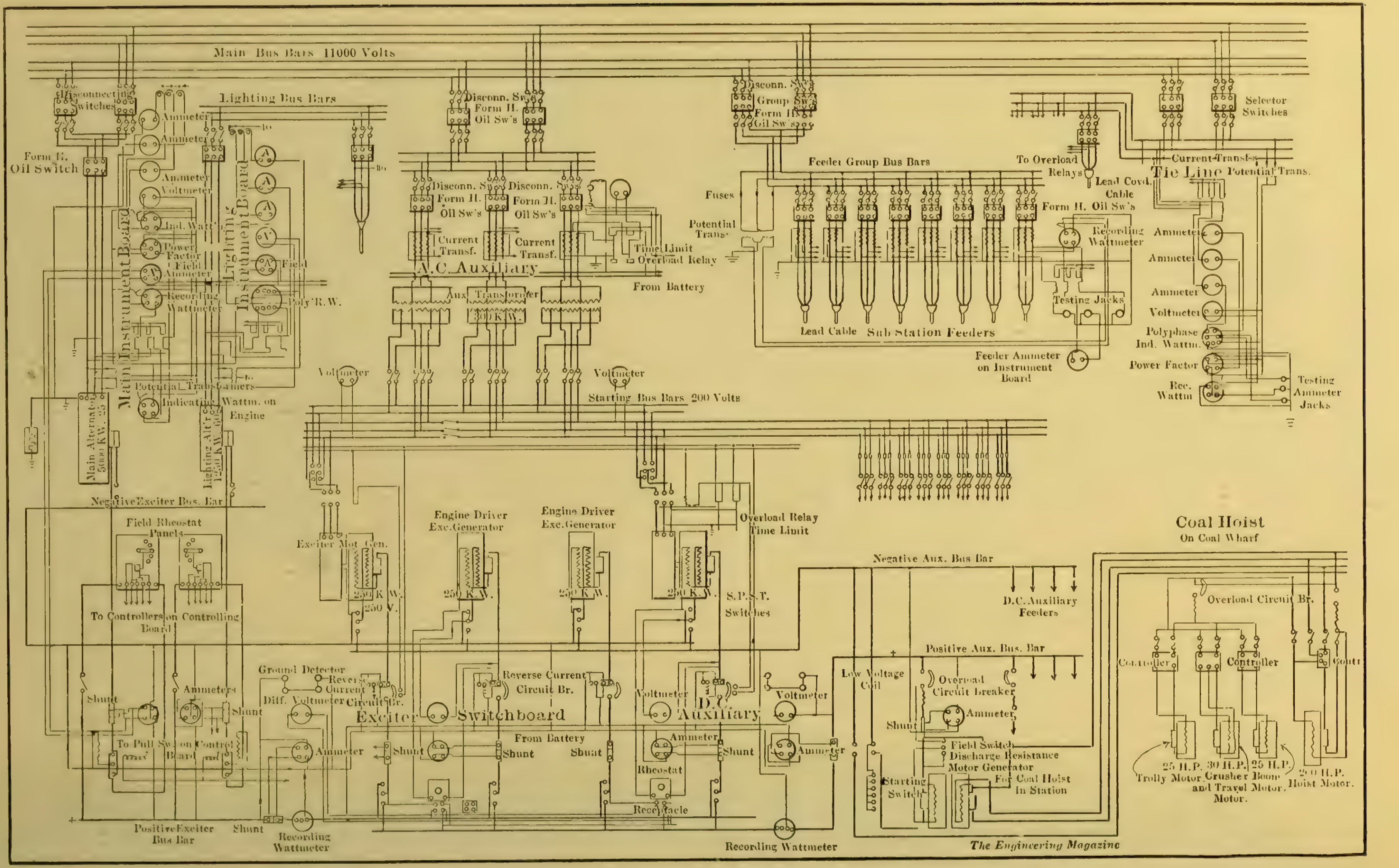


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FIG. 74. GENERAL WIRING SYSTEM, 59TH ST. POWER HOUSE OF THE INTERBOROUGH CO., NEW YORK.

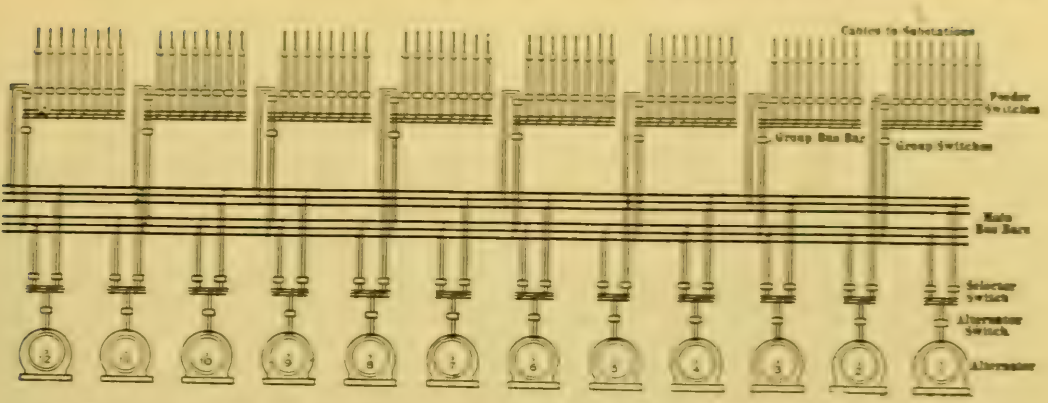


FIG. 75. DIAGRAM OF 15,000-VOLT CIRCUITS IN N. Y. SUBWAY POWER PLANT.

Figure 76. The instrument board of the former plant is of vertical steel construction faced with black marble panels, while the controlling board, a diagram of which is given in Figure 77, is constructed in the form of a desk, arranged and installed similarly to that shown in Figure 78, which illustrates an alternating-current and direct-current switch-board in a plant in Mexico, installed by the General Electric

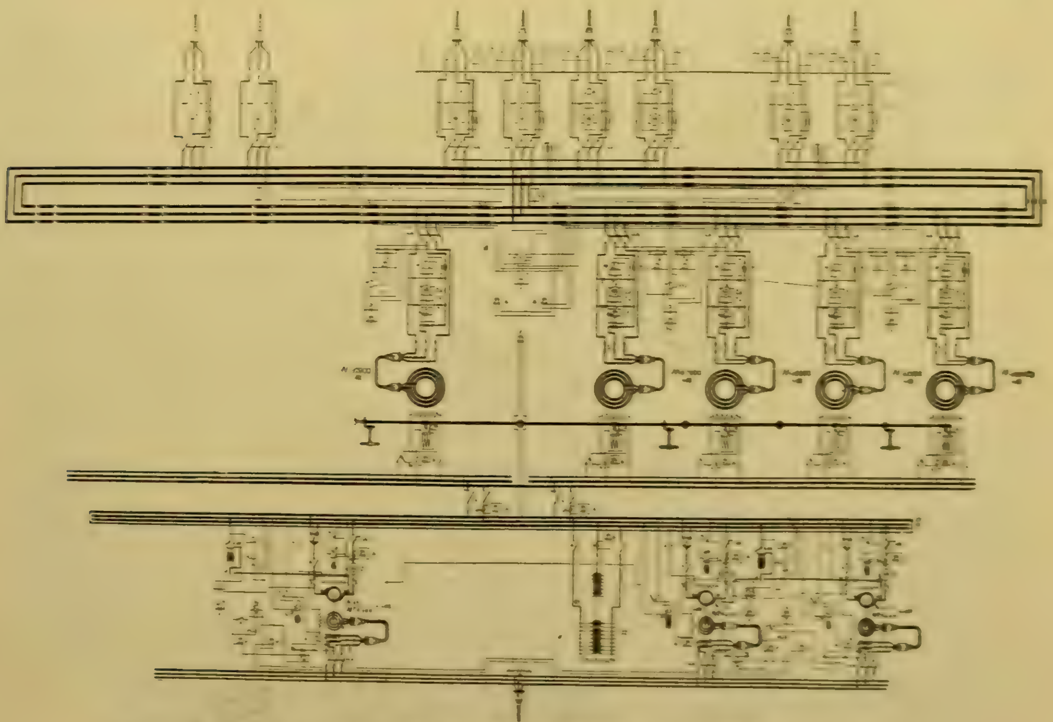


FIG. 76. WIRING SYSTEM OF TWIN MUNICIPAL PLANTS, VIENNA.

Co. The main oil-switch motors are operated from a storage battery at a potential of 110 volts. In connection with each controlling switch is installed a red and green bull's-eye lamp indicating the position of the switch. As will be noticed in the diagram of the controlling board,

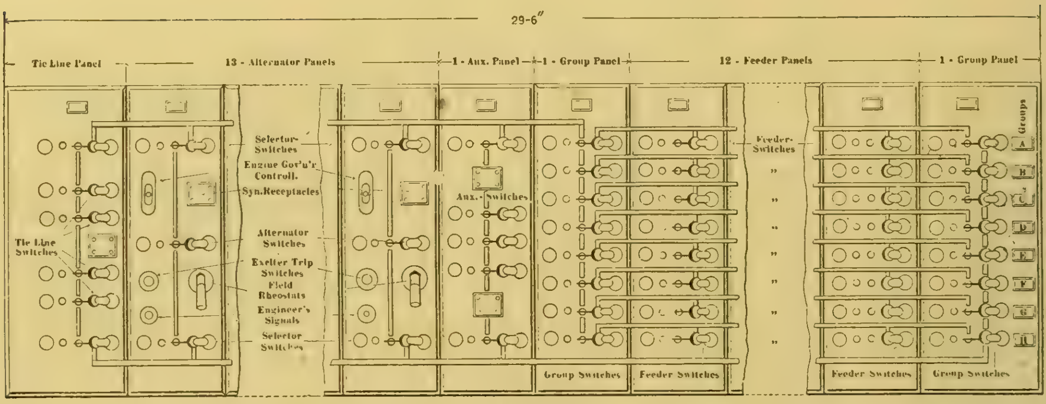


FIG. 77. DIAGRAM OF CONTROLLING BOARD, N. Y. SUBWAY POWER PLANT.

it is divided into two sections, one for the current from the generators to the buses, and the other between the buses and sub-station feeders. The oil switches which are now commonly used are placed

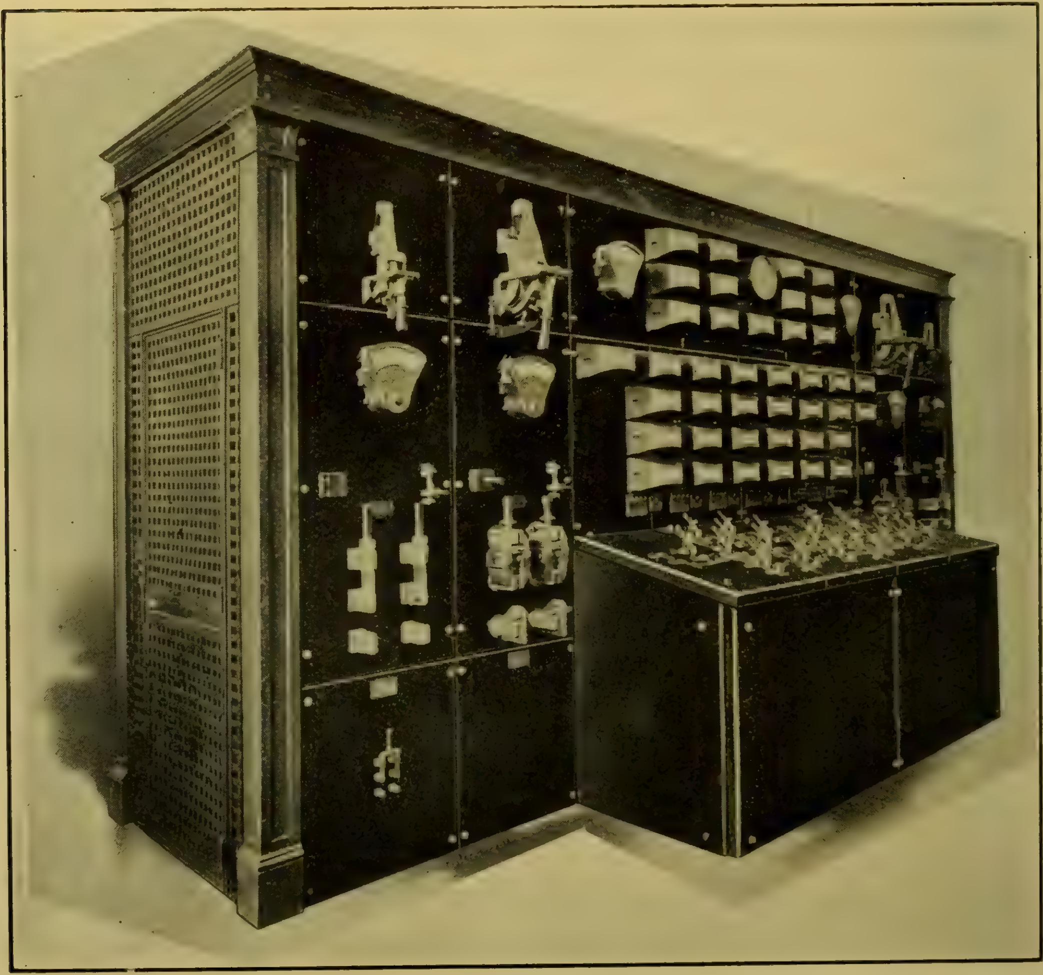


FIG. 78. 50-CYCLE ALTERNATING AND DIRECT-CURRENT SWITCH-BOARD FOR NECAXA POWER PLANT, MEXICO.

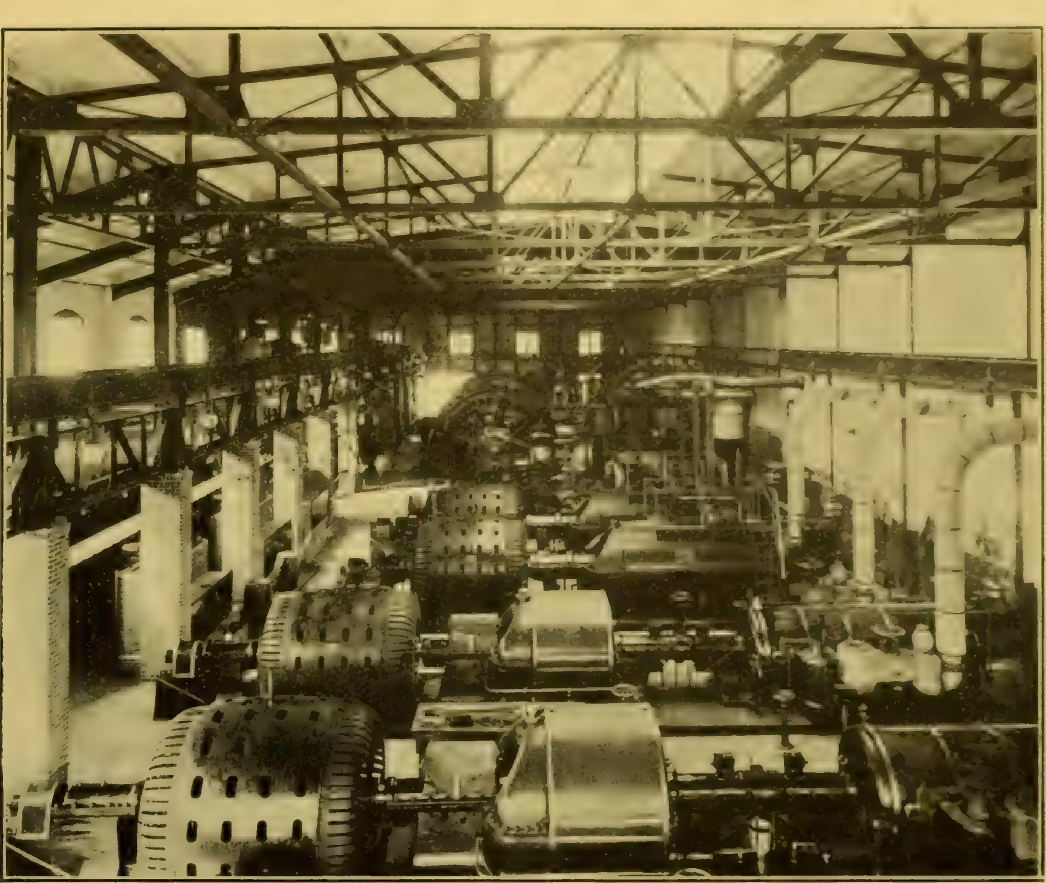
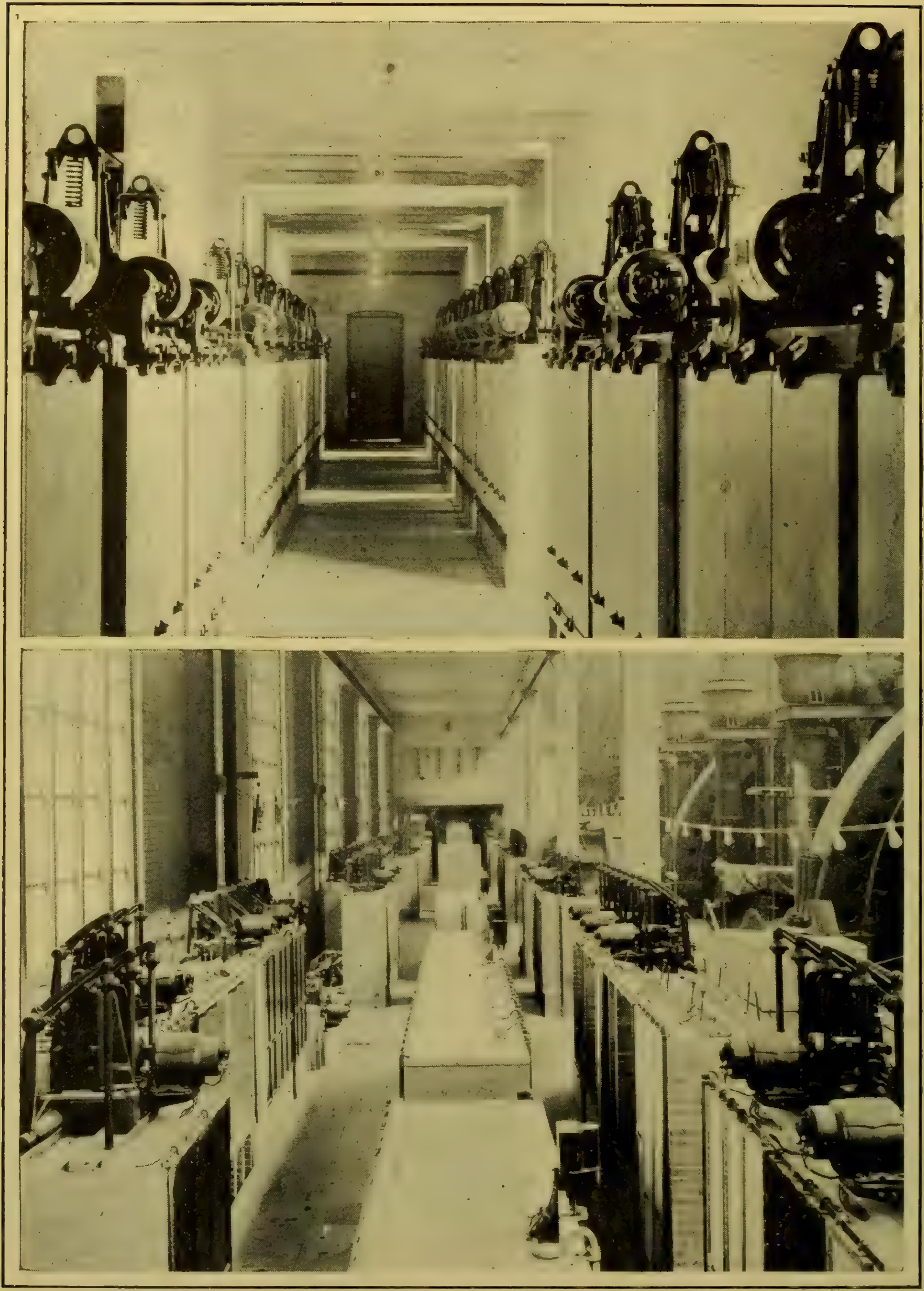


FIG. 79. A MODERN AMERICAN POWER STATION; PHILADELPHIA RAPID TRANSIT RAILWAY, 2ND ST. AND WYOMING AVE.

Showing four of the six 1,500-kilowatt Westinghouse turbo-generators installed, with engines of the old type in the background.

in fireproof compartments of either brick or concrete, the front openings being closed with either slate or soapstone slabs, or in some cases wired glass. In regard to the latter it may be noted here that in case of short circuit one is as liable to rupture as the other. The use of small electric motors for the operation of these switches is the most common American practice, while on the continent of Europe mechanical systems are more frequently found. The former system as developed by the General Electric Co. is illustrated in Figure 80 representing the apparatus in the switching room of the N. Y. Edison Co.'s water side power station and in that of the New York Subway power station. In both of these cases the six-pole switches are located entirely in a common compartment while in Figure 83, showing the interior of the compartment of a General Electric 30,000-volt oil switch, each phase has its own compartment. Another type of oil switch, mechanically operated, is illustrated in Figure 84, which represents a 40,000-volt (and higher) Brown Boveri



FIGS. 80-81. THE UPPER VIEW SHOWS THE OIL SWITCHES IN THE NEW YORK EDISON CO.'S PLANT, 38TH ST. AND EAST RIVER, N. Y. THE LOWER SHOWS THE OIL SWITCHES AND BUS-BAR COMPARTMENT IN THE 59TH ST. STATION OF THE INTERBOROUGH RAPID TRANSIT CO., N. Y.

General Electric Co., Schenectady, N. Y.

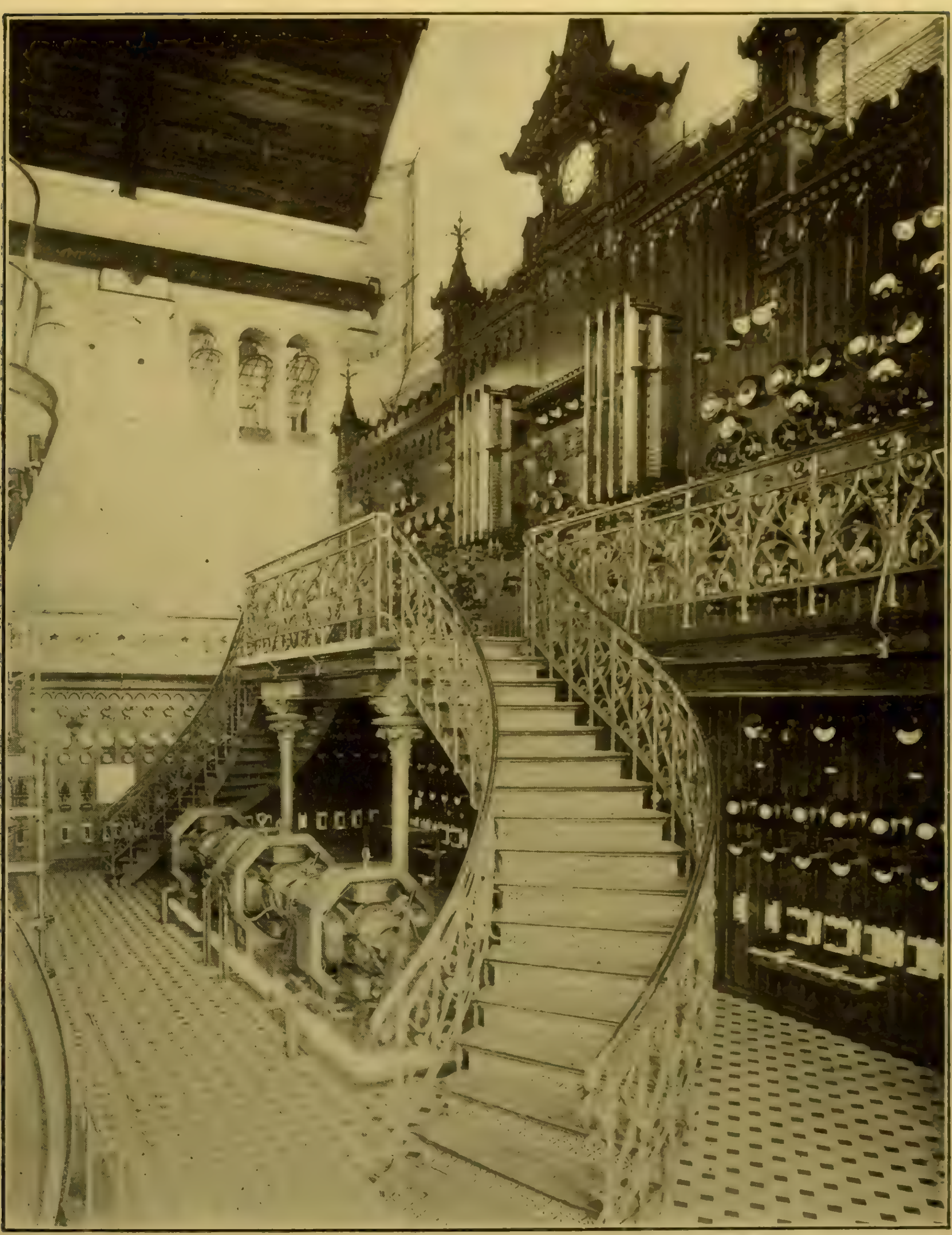


FIG. 82. SWITCH-BOARD FOR AN EARLY 600-VOLT DIRECT-CURRENT PLANT AT HAMBURG.
Schuckert & Co., Nuremberg.

switch. It will be noticed that here also each phase has its own compartment, on account of the high potential.

To the appearance of the instrument board itself, seemingly little attention is devoted in America compared to that given to this subject by the European designers. Indeed, the plainness of American switchboards is no more marked than that of the entire equipment of the

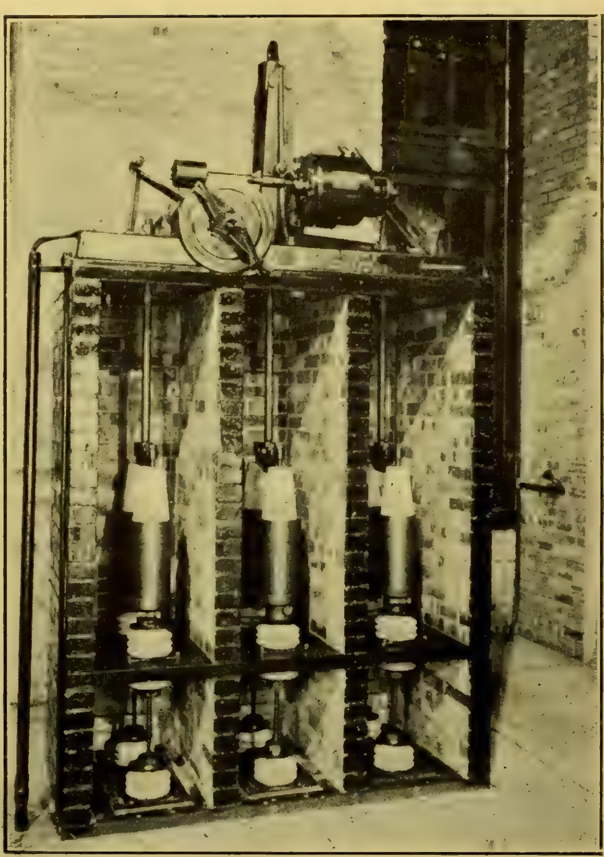


FIG. 83. 30,000-VOLT 50-AMPERE OIL SWITCH FOR OUTGOING FEEDERS.
General Electric Co.

power plants, everything in fact being designed for its utility only. I would like to suggest a more artistic design of such a structure bearing scientific instruments; the suggestion may also be applied to power-plant construction in Great Britain. Of course, the design of a switch-board as well as the entire plant, is largely a matter of taste, and undoubtedly the designer of the switch-board illustrated in Figure 82, by the Schuckert Co., Nuremberg, will have its critics (pro and con). This elaborate board is installed at the power plant "Zollvereinsniederlage," an early direct-current installation in the City of Hamburg operating at a potential of 600 volts. The later installed plants in this same city illustrated in Figure 85 have switch-boards of similar ornamental design, the frame work only, however, being constructed of wood and the panels of white marble, while in this case the board is entirely of wood and no difficulty has been experienced with its construction. It may be possible to construct boards of wooden skeleton for much higher voltages, provided that proper arrangements are made for the insulation of wiring and switches, although an iron frame with incombustible panels is far more advisable. An example of good modern continental practice is given in the Vienna plant, the switch-board of which is illustrated in Figures 87 and 88. This board is constructed entirely of iron and white marble. Another practice is to make the entire switch-board of iron, mounting the instruments directly on this frame with proper insulation. The Brown Boveri Co. have installed several of this type among which is that for the highest potential to-day employed in Europe, 40,000 volts. It is of the greatest convenience to have one panel devoted to each generator, in order to assure easy reading and operation.

To ensure reliable and economical operation of the power plant, in the electric as well as in the mechanical part, it is most desirable to give the design the most scientific consideration and to employ skilful operators. The installation of good modern apparatus (frequently called troublesome or complicated) not necessarily including labor-saving devices, has daily been proven on the continent of Europe to be most economical and advantageous, although its first cost and also the cost of maintenance be seemingly large. The results of this practice I have endeavored to show in examples especially in the preceding articles of this series (steam part of the plant) where economy is of greater importance and more often lost sight of—for example, the production of one indicated-horse-power hour for 9 to 10 pounds of water as against 13 to 15 pounds.

This is of course due not only to the progressive spirit and engineering skill of the manufacturer, but to a great extent depends upon the ability of the power-plant designer and the operator.

All tests in connection with the operation of the plant, whether satisfactory or otherwise, should be reported in the technical press, to give opportunity for criticism by competent engineers; this works not only for the general engineering advantage, but finally results in the manufacturers' material benefit.

Indeed, the spirit and policy of publicity is generally characteristic of the best modern practice, whether in the construction or

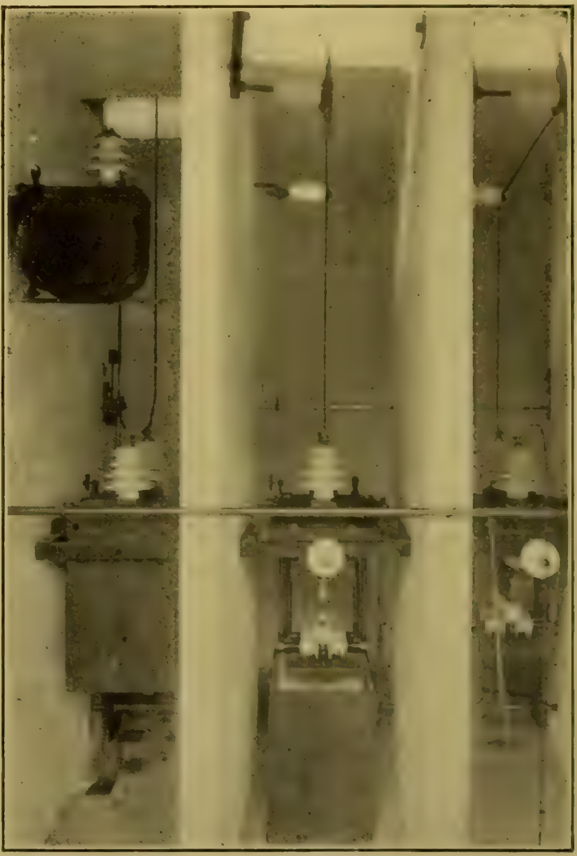


FIG. 84. 40,000-VOLT MECHANICALLY OPERATED OIL SWITCH.

Brown Boveri & Co.

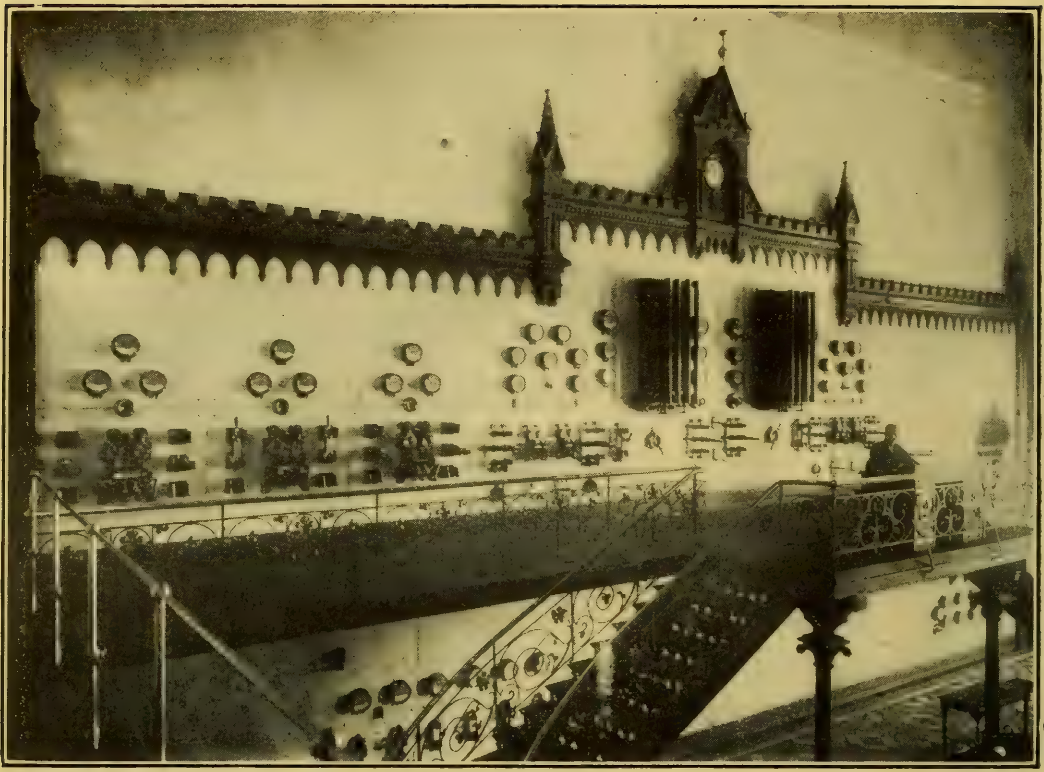


FIG. 85. SWITCH-BOARD AT THE "BILLE" CENTRAL STATION, HAMBURG.
Schuckert, Nuremberg.

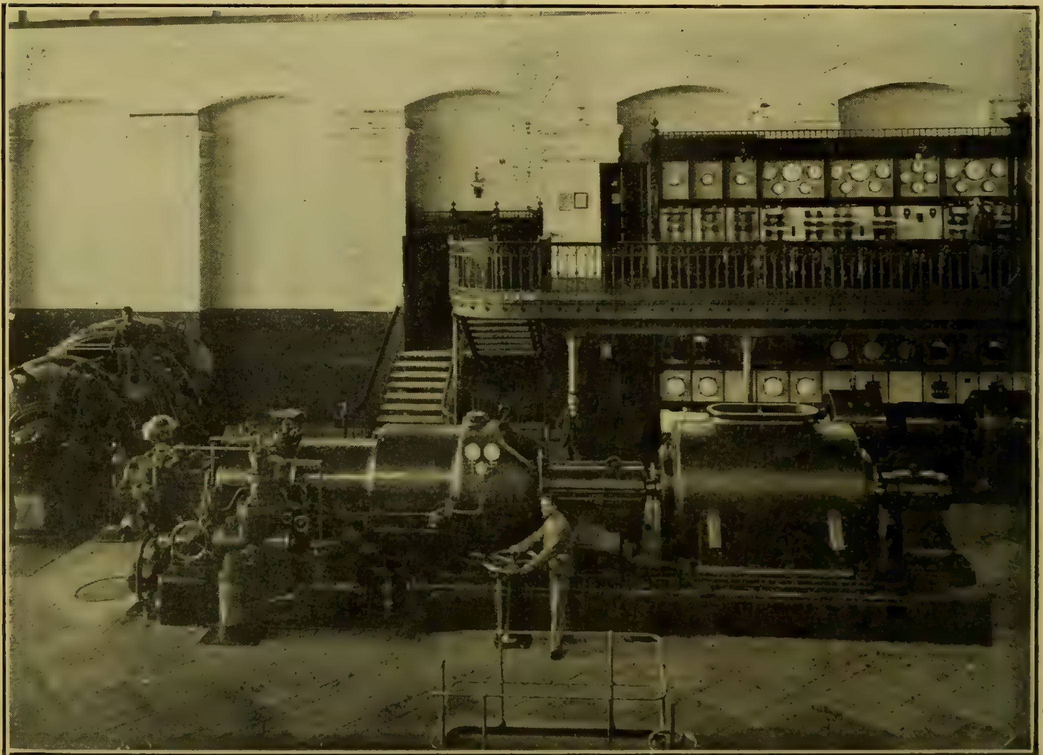


FIG. 86. PLANT OF THE SOCIETA ALTA ITALIA, TURIN.
The switch-board is seen in the gallery. The Brown-Boveri-Parsons turbines are of 2,250 horse power.

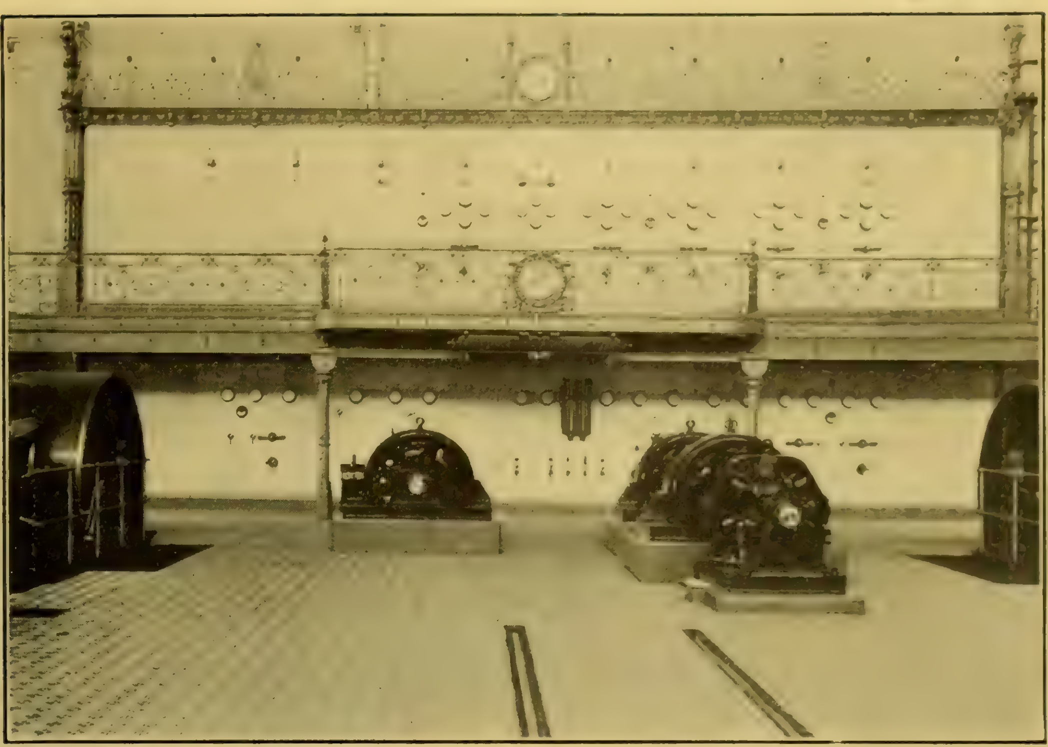


FIG. 87. MODERN SWITCH-BOARD IN THE VIENNA POWER PLANT.
Designed by the Siemens-Schuckert Co.

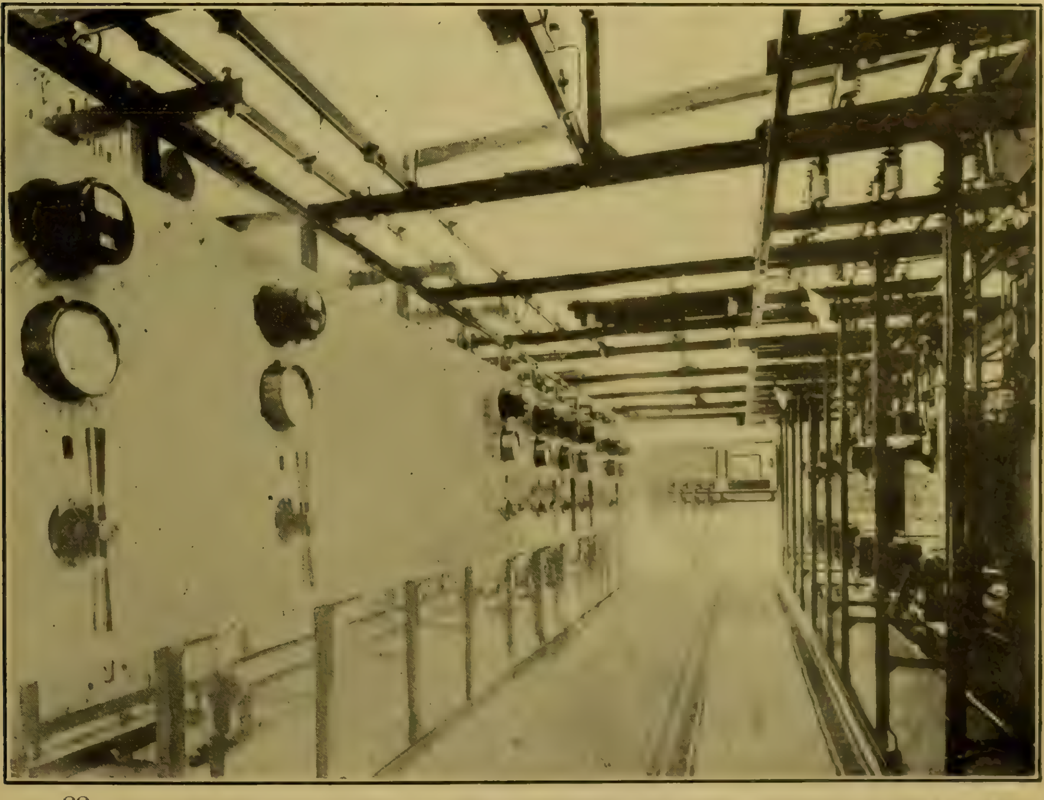


FIG. 88. REAR OF SWITCH-BOARD GALLERY, SHOWING BUS BARS, VIENNA POWER PLANT.

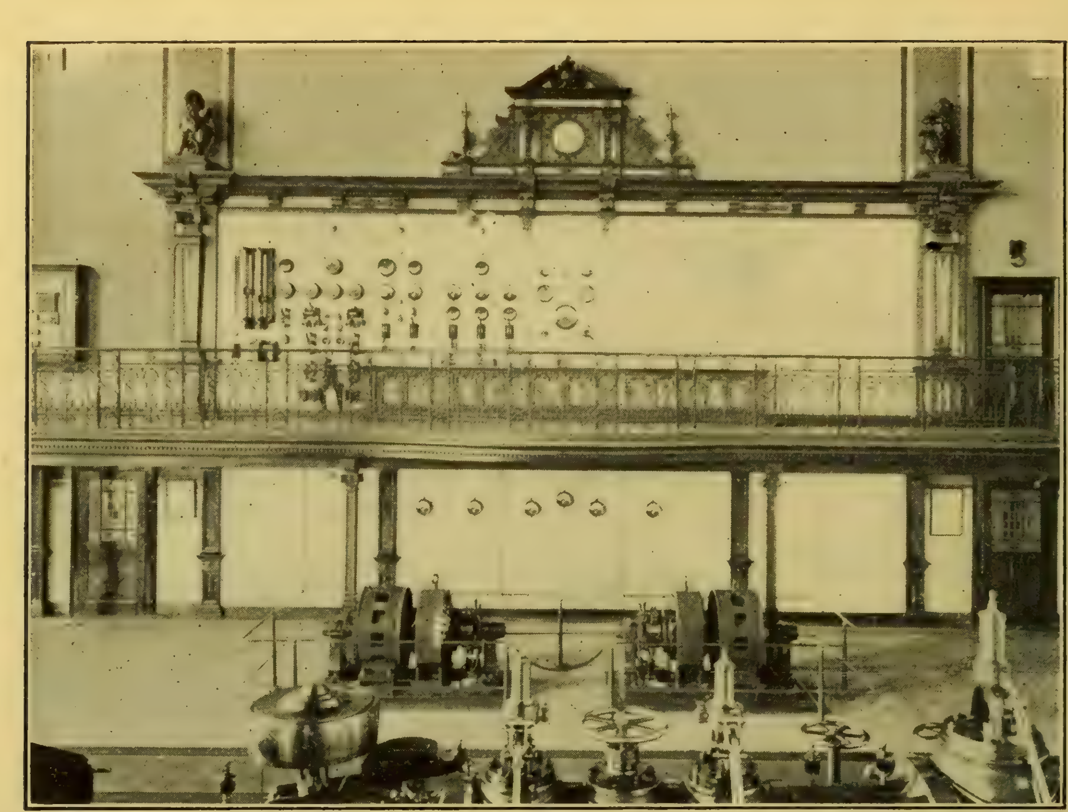


FIG. 89. SWITCH-BOARD AT THE CENTRAL STATION IN MAINZ, GERMANY. In front of it are seen two rotary transformers. Siemens-Schuckert Co., Berlin.

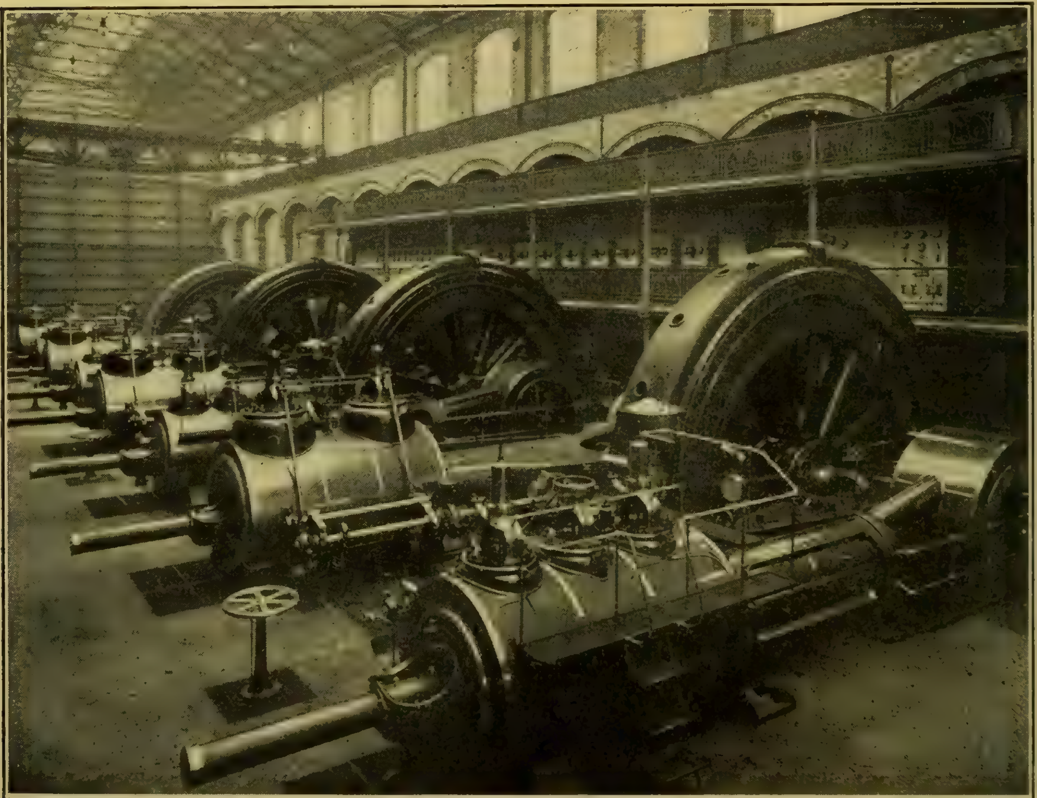


FIG. 90. BOW STATION, CHARING CROSS AND CITY ELECTRIC CO., LONDON. Showing switch-board in background. Sulzer cross-compound horizontal engines; 10,000 horse power in four units.

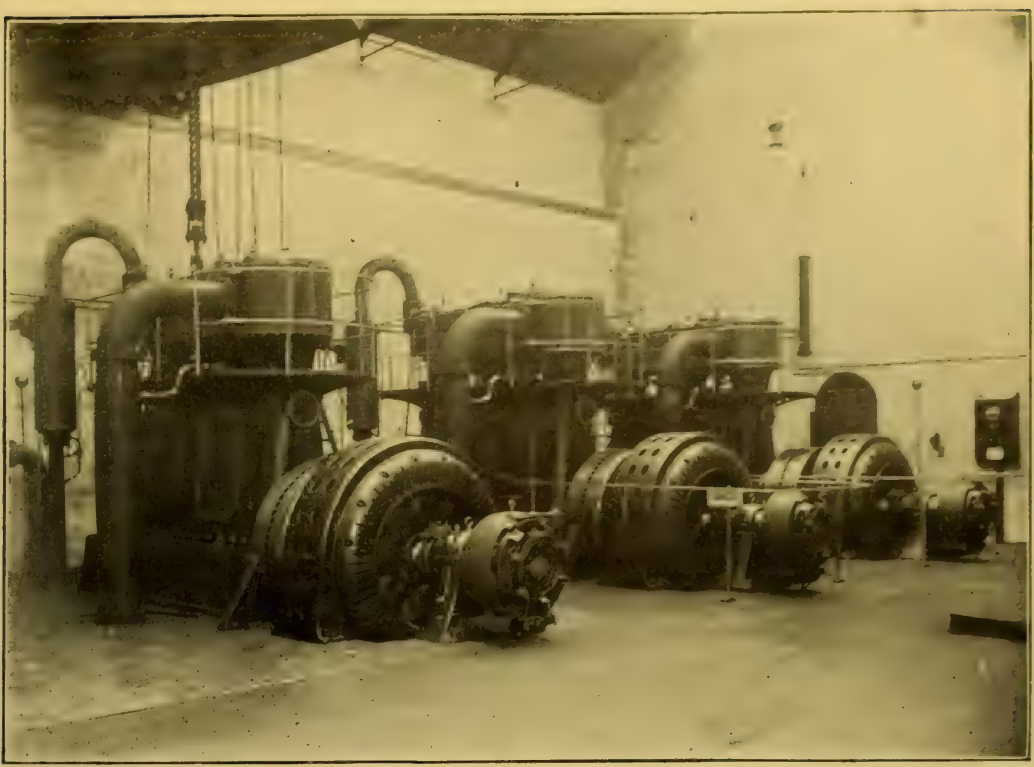


FIG. 91. LEEDS AND WAKEFIELD TRAMWAYS POWER HOUSE, ENGLAND.

Three triple-expansion engines built by Messrs. James Hawden & Co., each coupled direct to a 400-500 kw. generator by Messrs. Dick, Kerr & Co., Ltd.

operation of engineering works. Those who have the most to give are usually the freest in giving out information of this kind. Apparently, also, the broad-minded policy brings its own reward, in that the data it supplies to professional workers, falling upon fertile ground, are taken up and cultivated by many minds, and return to the sowers eventually a harvest many fold greater in value than the original seed.

It remains for me to express thanks to the numerous companies, both in America and Europe, for the illustrations which they kindly furnished regarding modern power-plant designs and economics.

THE MINERAL INDUSTRIES OF THE UNITED STATES

By Edwin C. Eckel.

Mr. Eckel is strikingly successful in bringing out clearly the proportionate importance of the various products of the mine—metallic and non-metallic. He avoids all monotony of figures, and makes the facts stand out in strong relief. The results will probably be something of a surprise to many readers, and perhaps the most interesting will be the enormously greater importance which is shown to attach to the mineral products immediately connected with engineering development, and the phenomenal growth of the cement industry.—The Editors.

IT is difficult to estimate justly the importance of the mineral industries to the prosperity of the United States, for one is apt to be led to opposite extremes, depending on the personal point of view. On the one hand it may be pointed out that over a third of the population of the country are engaged in agricultural pursuits, while only about a fiftieth of its workers are employed in mining. If such data could be accepted as bases for comparison, it would be difficult to work out a good case for the industries which are the subject of this article. But if we recollect that a very large proportion of our manufactures are dependent on raw materials of mineral origin, that the transportation industries are largely based on the same raw materials, and that one important duty of the farmer is to feed the miner and furnaceman, the case assumes a brighter aspect.

There is danger, on the other hand, of going to the opposite extreme, and overestimating the importance of the mineral deposits and the industries which are dependent on them; and the best corrective for such an overestimate would be the examination of the comparative figures given below.

Taking the United States Census results as a basis, it is stated in the report on population that of the total workers in the United States the percentage employed in mining or quarrying has been as follows:

1880	1.4 per cent.
1890	1.7 per cent.
1900	2.0 per cent.

The mining interests of the country are thus increasing gradually, compared with other industries, and at present one in every fifty American workers is directly employed in either mining or quarrying.

These figures, however, hardly represent the true importance of the mineral industries, because they include only those who are employed immediately in the work of getting the crude ore or rock to the surface. A more satisfactory method of calculation would be to include, with these, the workers employed in certain industries most closely allied to mining. Blast-furnaces, coke works, salt refineries, cement mills, and similar plants are so directly connected with the mineral industries that their employees may properly be included in the calculation. In each of the allied industries just mentioned, the work being done is simply the putting of the raw material into condition for its first sale, not the preparation of a finished product.

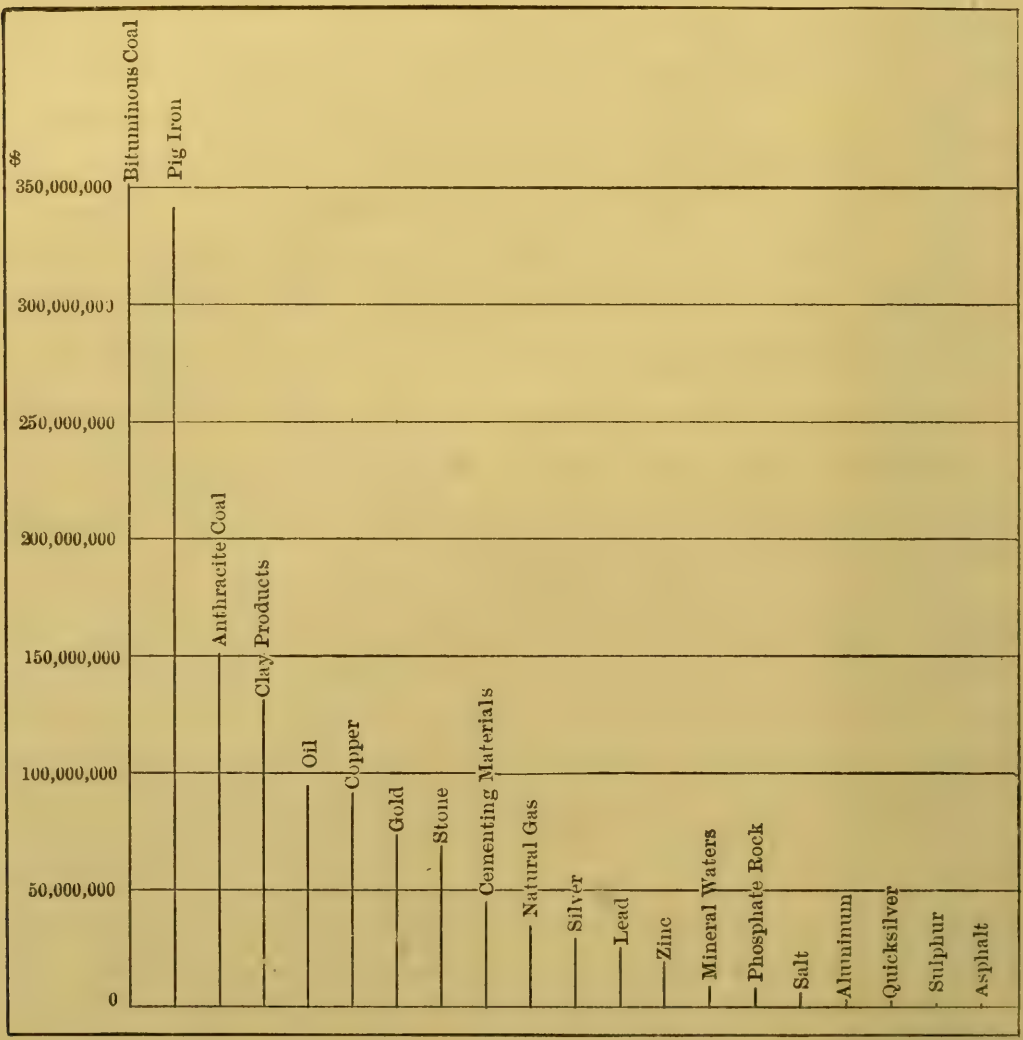
Using this as a criterion, the following data can be obtained by careful examination of the Census reports:—

	1900.		1890.	
	Number.	Per Cent.	Number.	Per Cent.
Total workers in the United States....	29,073,233	100.0	22,735,661	100.0
Miners and quarrymen...............	580,761	2.0	387,248	1.7
Furnaces and allied industries........	525,185	1.8	439,197	1.9
Total directly interested in mining..	1,105,946	3.8	826,445	3.6

The totals above given indicate that, of all the workers in the United States, about one in twenty-six is directly interested in the mineral industries, taken as a whole.

If the figures for the separate States be examined, it will be seen how strikingly these industries are concentrated in certain States. In Pennsylvania, for example, over 400,000 persons, representing more than 30 per cent. of the State's working population, are engaged in mining or in closely allied pursuits. The other extreme is to be found in Mississippi, where only 21 persons, out of a population of over 1,500,000, are employed in mining work. Montana, Colorado, Arizona, West Virginia, Nevada, and Idaho rank close to Pennsylvania in the percentage of their population interested in the mineral industries; but far below her in the totals, because of their smaller population.

This statement as to Pennsylvania's rank may serve as a hint toward obtaining a correct idea of the relative value of the different mineral products of the country, compared among themselves. It is not gold and silver which are of greatest commercial importance, but coal and iron; and a realization of this fact would serve to correct many misapprehensions concerning the mineral industries. We are apt to be dazzled by the high unit value of gold, and to lose sense of true proportion. We all know from personal experience that gold is the most valuable—and scarcest—of the metals which we ordinarily encounter; we know, further, that States and territories have been populated by gold seekers, and that thousands of men are now engaged in prospecting and mining for this most precious metal. And then, by a bit of faulty reasoning, we are likely to arrive at the *very* faulty conclusion that gold must be the most important of our mineral products. As a matter of fact it is, as will be seen later, far from occupying first place.



The Engineering Magazine

FIG. I. ANNUAL PRODUCTION OF THE PRINCIPAL MINERALS IN THE UNITED STATES.

The facts regarding the relative importance of the various mineral products are brought out most strikingly in the accompanying diagram which shows graphically their values for the year 1903. It will be seen that bituminous coal is by far the most important product, forming with pig iron a very distinct class. Below these come another group, headed by anthracite coal and clay products, and including such diverse materials as copper, petroleum, gold, and building stone. Gold, it will be observed, ranks no higher than seventh among American mineral products; while the high rank given to bricks and building stone will probably surprise the reader.

A third group consists of natural gas, silver, lead, cement, and zinc—another heterogeneous class. Below this would come, in order, mineral waters, phosphates, and salt.

The most striking feature is that the non-metallic minerals far outclass the metals in value. Elsewhere* I have summarized this phase of the subject as follows:

> "From the purely commercial point of view, therefore, the non-metals are by far the more important of the two classes. From the point of view of human comfort, the disparity in importance is just as striking. We could contemplate with some serenity the possibility of having to live without copper—but not the necessity of existing without salt. A scarcity of gold is certainly inconvenient, but not to be compared for discomfort to a lack of fuel. With the single exception of iron, the metallic products are objects of convenience or luxury, while many of the non-metals are necessaries of civilized life."

These facts will be brought out more clearly when the different mineral products, or classes of products, are separately considered.

Mineral products are so many, and of so varied characters, that no satisfactory discussion of the subject can be attempted unless the different products are grouped or classified in some convenient fashion. This has accordingly been done in the following table, and in order to indicate the relative commercial importance of these groups, the values for the year 1903 have been computed and added:—

	Value, 1903.
Fuels	$634,233,791
Iron	344,350,000
Structural materials	219,094,500
Precious metals	102,913,700
Copper	91,506,000
Other non-metals	59,635,120
Other metals	44,864,242

Of the total value of mineral products for this year, which amounts to almost one and one-half billion of dollars, the non-metallic products contributed over three-fifths. As the first three groups above listed are of peculiar importance, both in the total value of their output and in their indirect effects on trade, they will be separately discussed in a little more detail.

Fuels.—Of the $634,000,000 produced in 1903 by the deposits of

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***Mining Magazine*, September, 1904.*

mineral fuel in the United States, considerably over half is to be credited to bituminous coal, a quarter to anthracite, about a seventh to petroleum, and one-twentieth to natural gas. This gives some idea of the relative values of the output of the different fuels. Their enormous aggregate value represents, it will be noted, about 40 per cent of the total mineral production of the country. A glance at Figure 1 will further show that the bituminous-coal output alone amounts to seven times the gold production; that anthracite outvalues gold two to one, while even petroleum has a greater total than gold and silver together.

The four products here included under the head of fuels are, as above noted, very unequal in importance. The most important by far—bituminous coal—is rather widely distributed east of the one hundredth meridian, while the territory west of that line is scantily supplied. The result of this scanty coal supply is that the iron industry is poorly developed in the west, notwithstanding the occurrence there of large deposits of rich iron ores.

Anthracite coal, whose non-smoking properties give it an importance far out of proportion to its fuel value, is developed in similar geographic fashion. Over 99.9 per cent. of American anthracite comes from a comparatively small area in eastern Pennsylvania, the remainder being produced in Colorado and New Mexico.

Petroleum and natural gas are distributed somewhat more equally. In 1903, almost one-fourth of the total oil production came from California, about one-fifth from Ohio, one-sixth from Texas, one-eighth from West Virginia, one-ninth from Pennsylvania, and one-eleventh from Indiana. A dozen other States contributed small percentages to the output. The most striking change in recent years has been the westward shifting of the oil industry, owing to the discoveries in California, Texas, and other States west of the Mississippi, coincident with decreases in the output of eastern States.

Natural gas, though widely distributed, is still supplied mostly by the middle States. Pennsylvania alone produces almost half of the total output, followed by Ohio, West Virginia, and Indiana in the order named. These four States together produce over 90 per cent of the entire supply.

Entirely aside from their value as marketable commodities, the location of fuel deposits has exerted a powerful influence on the development of the other mineral industries. An area where good coals are scarce can hardly hope to become important as an iron-producing district, even if it contains large deposits of high-grade iron ore. The case is similar with regard to the clay, cement, and chemical industries; many extensive beds of raw deposits suitable for these industries being rendered practically valueless by the absence of fuels. Absence of fuel prevents the development of anything except high-grade deposits of precious or semi-precious metals.

On examining the next subject—iron—a very good example will be found of the control which fuel supplies exert over other industries.

Iron.—In discussing the iron industry of the United States, two distinct phases of the subject are to be considered—the mining of iron ores, and the production of pig iron. The two industries are necessarily closely related, but as will be seen later they differ very widely in geographic distribution.

The iron-mining industry will naturally be considered first. In the table below, the iron-ore production of the various States is given, in long tons, for the year 1903.

	Long tons.
Minnesota	15,371,396
Michigan	10,600,330
Alabama	3,684,960
Tennessee	852,704
Virginia and West Virginia	801,161
Wisconsin	675,053
Pennsylvania	644,599
New York	540,460
New Jersey	484,796
Georgia	443,452
Nevada, New Mexico, Utah and Wyoming	392,242
Colorado	252,909
North Carolina	75,252
Missouri	63,380
Texas	34,050
Kentucky	32,227
Connecticut and Massachusetts	30,729
Ohio	29,688
Maryland	9,920
Total United States	35,019,308

These figures can be rendered more intelligible and valuable if the States are arranged in the natural groups which immediately suggest themselves. When this is done the following results are obtained, as shown in both tons and percentages of total output:

	Tons.	Per Cent. of Total.
Lake Superior District	26,646,779	76.1
Southern United States	5,997,106	17.1
Central and Eastern United States	1,730,272	4.9
Rocky Mountain States	645,151	1.9
	35,019,308	100.0

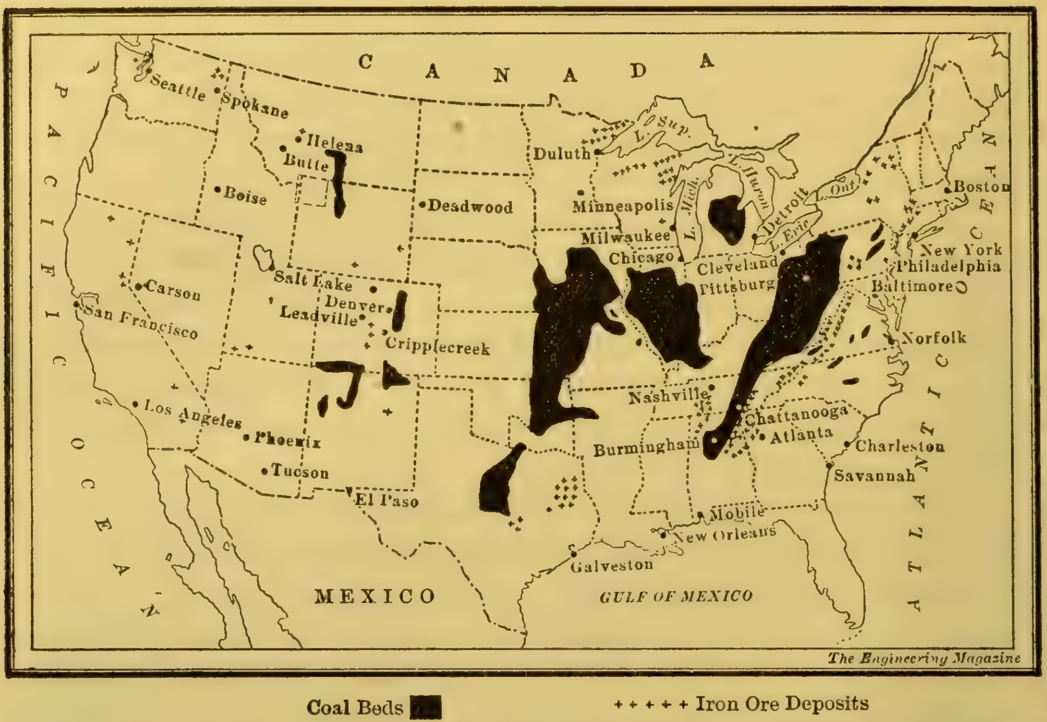


FIG. 2. MAP OF THE UNITED STATES, SHOWING THE PRINCIPAL COAL AND IRON DEPOSITS.

From this it will be seen that the Lake district produces slightly over three-fourths of the total output; while the southern States produce about one-sixth, the central and eastern States one-twentieth, and the western States one-fiftieth. Fifty years ago such a geographic distribution of the production of iron ores would have implied a similar distribution in the production of pig iron, for at that date furnaces were almost invariably located near the mines. But at the present time this is far from being true. Transportation facilities have improved so remarkably, in certain lines, that the furnaces are now located as near as possible to the markets and the fuel supply, rather than near the mines. This is particularly true with regard to the furnaces which obtain their ores from the Lake district, since these are located chiefly in Pennsylvania, Ohio, Illinois and western New York. The Southern plants, more favored by nature, are located close to both iron ore and coal.

The 35,000,000 tons of ore produced in the United States during 1903, plus about 1,000,000 tons of imported ore, yielded 18,000,000 tons of pig iron. The distribution of the pig-iron production is shown in the upper table on the following page.

Comparison of this table with that previously given for the ores shows the remarkable differences in the localization of the two in-

Production of Pig Iron in 1903, by States.

	Long Tons.
Pennsylvania	8,211,500
Ohio	3,287,434
Illinois	1,692,375
Alabama	1,561,398
New York	552,917
Virginia	544,034
Tennessee	418,368
Maryland	324,570
Wisconsin and Minnesota	283,516
Missouri, Colorado and Washington	270,289
Michigan	244,709
New Jersey	211,667
West Virginia	199,013
Kentucky	102,441
North Carolina and Georgia	75,602
Connecticut	14,501
Texas	11,653
Massachusetts	3,265
Total	18,009,252

dustries. These differences are brought out still more strikingly when the States are combined in groups. In the table below this has been done for both iron ores and pig iron, the production of each group of States being given both in tons and in percentages of the total.

	Iron Ore.		Pig Iron.	
	Tons.	Per cent. of total.	Tons.	Per cent. of total.
Lake Superior district	26,646,779	76.1	528,225	2.9
Southern States	5,997,106	17.1	3,287,368	18.3
Central and Eastern U. S.	1,730,272	4.9	13,973,659	77.6
Rocky Mountain States	645,151	1.9	220,000	1.2
	35,019,308	100.0	18,009,252	100.0

The geologic and economic facts which have caused these conditions may be stated briefly as follows:—

In the Lake Superior district immense deposits of hematite occur, largely of Bessemer grade. Fuel is scarce, and the ore is therefore shipped to furnaces in the central and eastern States, via the water route of the Great Lakes.

On the western side of the Appalachian Valley, occurring at intervals from New York to Alabama, great deposits of an oolitic red hematite—the "Clinton fossil ore"—occur. These ores are particularly well developed in Tennessee and Alabama, where they are cheaply mined. In these States the Clinton ore beds are located close to beds of coal and limestone. Being rarely low enough in phosphorus for Bessemer use, the fossil ores are used for foundry iron and open-hearth steel.

In the Appalachian Valley itself, from Vermont to Alabama, large but irregular deposits of brown hematite are found. In Virginia, Tennessee and Alabama, where fuel is within reach, these deposits have been extensively worked for foundry and basic iron.

In the Adirondacks, the Highlands of New York and New Jersey, and the Blue Ridge, deposits of magnetite are frequent. Several of these are extensively worked, but many contain prohibitive percentages of titanium or else are so lean as to require concentration.

The Rocky Mountain and Pacific States contain many large undeveloped bodies of ore, chiefly magnetite and hematite. Owing to distance from fuel and markets, and high transportation charges, less attention has been paid to these deposits than they deserve.

Structural and Engineering Materials.—Few economic movements of recent years have equalled in importance the growth of the industries based on the non-metallic structural materials. In this group are included the stone used for building or road purposes, such clay products as are used in engineering, and the various cementing materials. The production of structural materials in the United States for the years 1902 and 1903 has been summarized in the following table:—

	1902.	1903.
Stone	$64,559,099	$67,960,468
Brick, tile, etc.	98,042,078	105,526,596
Cements, limes, plasters, etc.	36,849,943	45,607,436
Total	$199,451,120	$219,094,500

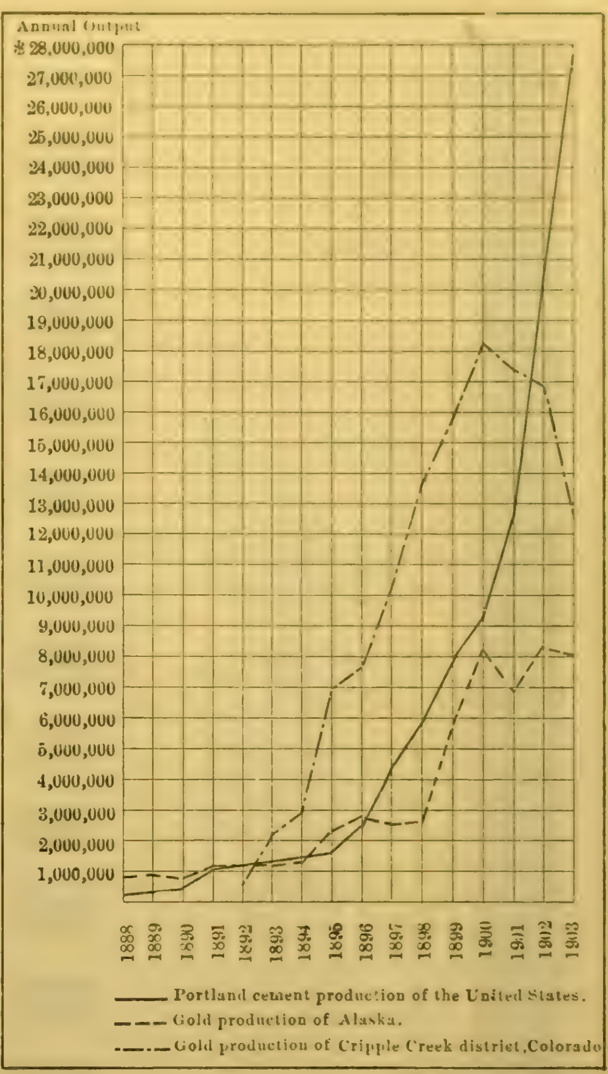
Of the three sub-groups of materials quoted in the above table, the third—the cementing materials—is at present of greatest interest, though it is still surpassed in value by the other two. The following table gives in more detail the value of the production in the United States, for the years 1900-1903 inclusive, of the six classes contained in the general group of cementing materials.

VALUE OF CEMENTING MATERIALS PRODUCED IN THE UNITED STATES, 1900-1903.

	1900	1901.	1902.	1903.
Plaster of Paris, wall plaster, etc.	$1,500,270	$1,325,517	$1,889,190	$3,550,390
Lime	6,970,062	8,597,030	9,573,011	10,105,190
Magnesia and magnesite	19,333	43,057	21,362	20,515
Natural cement	3,728,848	3,056,278	4,076,630	3,675,520
Portland cement	9,280,525	12,532,360	20,864,078	27,713,319
Slag cement	274,208	198,151	425,672	542,502
Total, cementing materials	$21,773,246	$25,752,393	$36,849,943	$45,607,436

It will be seen that the value of the entire group has more than doubled in these four years. Examination of the figures for each subgroup will show that this increase was by no means equally distributed. The production of Portland cement almost tripled in value from 1900 to 1903; the values of the plaster and slag-cement production about doubled; while lime increased only 50 per cent, and magnesia and the natural cements were practically stationary.

The increase in the value of the American Portland cement production is a feature to which particular attention should be drawn. The manufacture of this product was commenced in the country about 1875, but in 1889 its annual production amounted to only $500,000. Since that date, however, the advance has been marvellous. The remarkable rate of increase is best shown in Figure 3, where the Portland cement production of the United States for the years 1888-1903 is plotted side by side with two much more widely advertised industries. Every one knows of the gold discoveries of Cripple Creek and in Alaska, but a glance at this diagram will show how unimportant were these rich finds of the precious metal in comparison with the quiet growth of a more important industry.

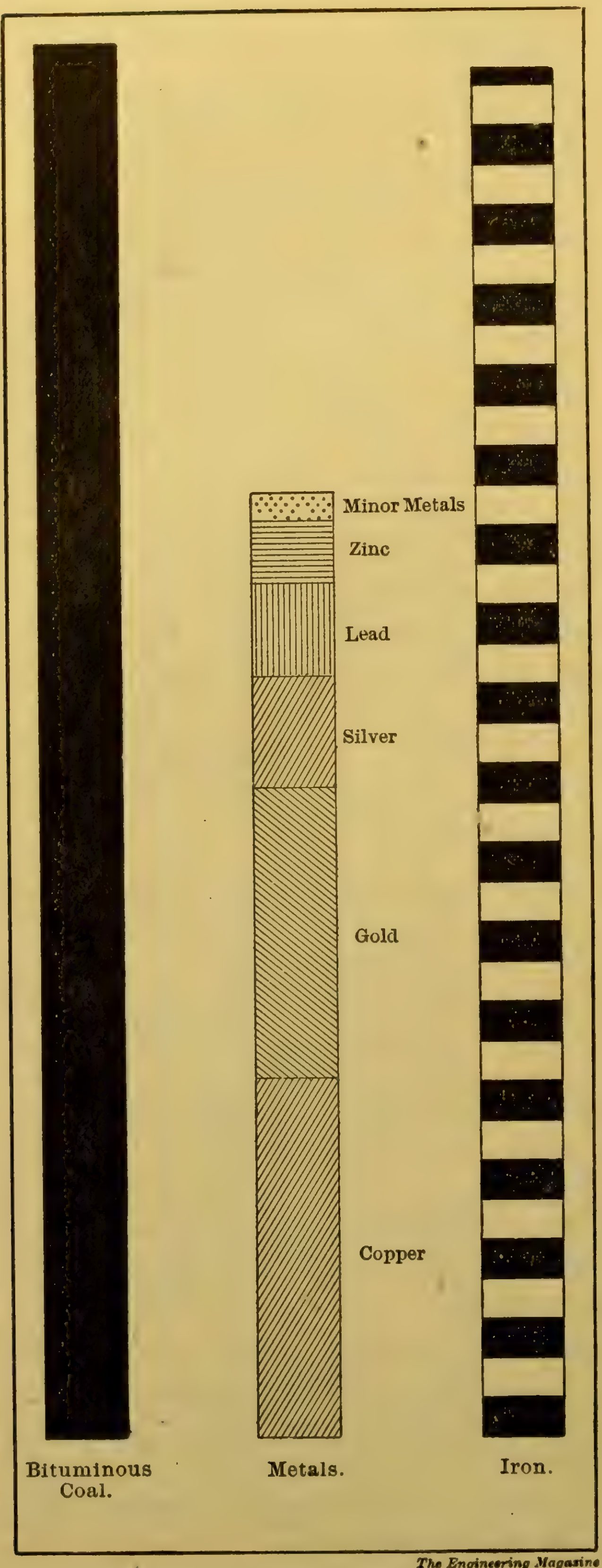


The Engineering Magazine

FIG. 3. GROWTH OF THE AMERICAN CEMENT INDUSTRY.

It will be seen that the three great groups which have been discussed—the fuels, iron, and the structural materials—account for over 80 per cent of the total mineral production of the United States. The remaining 20 per cent is made up by a very heterogeneous collection of products, including some—such as gold, silver and copper—which are often considered to be of great importance.

The fact that these three groups make up four-fifths of the mineral



COMPARATIVE PRODUCTION IN 1903.

output is, of itself, quite striking. But the situation becomes still more interesting when the *indirect* value of the products is taken into consideration, for iron, the fuels, and the structural materials are all of low unit value, and their output must be of immense tonnage in order to place them ahead of more costly products. The aspect from this point of view is brought out in the accompanying figure, showing the comparative production of coal, iron, and the metals in 1903. This immense tonnage implies, in turn, the employment of much capital and labor in handling and transporting such products. One thousand dollars' worth of pig iron, for example, would be perhaps seventy tons; one thousand dollars' worth of gold would be little over four pounds. It can readily be seen that the production of one thousand dollars' worth of iron will give indirect employment to much more capital and labor than will the production of the same value of gold.

A STUDY OF THE CORROSION OF CONDENSER TUBES.

By A. Humboldt Sexton.

Professor Humboldt Sexton's opportunities for the thorough and practical examination of his subject have been unusual, and his conclusions will impress his readers as being very well supported. They appear to point the way to the prevention of an annoying and serious trouble which has perplexed marine engineers and other steam users, and will be proportionately welcome to those who have suffered from the phenomena discussed. Professor Sexton, on his part, will welcome discussion of his results, and co-operation in the further study of the subject by way of the contribution either of experience with condenser-tube corrosion or of materials showing its effects.—THE EDITORS.

THE corrosion of condenser tubes is one of the difficulties which the marine engineer has constantly before his mind, for not only do the failures thus caused give him endless trouble, and put him to considerable expense, but the corrosion takes place in so many ways and seems to be so erratic that it is almost impossible to guard against it, and in the minds of many engineers there is a feeling of uncertainty and insecurity which is far from pleasant.

I have had the opportunity of investigating certain cases of bad corrosion of condenser tubes, and have devoted a considerable amount of time to the experimental study of the subject; this paper is therefore submitted as a summary of the present position of our knowledge with reference to this subject, and at the same time as a contribution to its further study. It is not hoped to answer definitely all the questions that may be asked, or to solve all the difficulties that arise in practice, but perhaps to make clear the principles on which corrosion depends, and to record results which may serve as a basis of future work.

At the outset it may be advisable to say a word or two as to the phenomena of corrosion as seen in condenser tubes, and all the points mentioned will be referred to later. It is assumed that the tubes are of brass, containing 70 per cent of copper and 30 per cent of zinc, which is the composition most generally used. When the tubes are removed from a condenser as being worn out, or at any rate, as being unfit for further use, probably on account of the failure of some of them, they will usually be in one of three conditions:—

(1) The tubes may be worn down nearly uniformly, the thickness of the metal being often considerably reduced, though of course it will be thinner in some places than in others. On making a section the remaining portion of the tube appears to be of brass quite unchanged.

(2) The tube may be considerably reduced in thickness, and as before to some extent uniformly, but there may be pitting here and there, and the inner surface of the tube seems to have become converted into copper—that is, it is dezincified—and this change in some cases may have gone to a very considerable depth.

(3) The tube may have worn down very irregularly, dezincification being well marked, often in patches, and sometimes extending at various places quite through the metal, giving the appearance of small plugs of copper, which may be either firmly adherent or quite loose; probably there will also be holes corroded through the tube—few or many, as the case may be. These plugs of copper and the holes will usually lie almost in one line, this line being at or near the bottom of the tube, when it is in position in the condenser.

Tubes in the first condition will usually have stood well, and may have been in use many years, those in the second condition may have lasted fairly well, but those in the third will usually have had a short life. The tubes which give trouble to the engineer are often found to be in the third condition.

In addition, there may be corrosion or dezincification to a smaller extent from the outside or steam side of the tube, but this is usually due to causes different from those which cause the corrosion from the inside.

The tubes also frequently contain more or less deposit, but this varies so much in appearance that it is impossible to give a general description. Sometimes the tubes are nearly clean inside, and almost free from deposit; sometimes there is a thin skin of black material; whilst in other cases, and often where the tubes have stood badly, there is a heavy deposit, black or brown in colour and containing a large amount of ferric hydrate. There are also usually patches, and sometimes a layer of a green deposit which is often very irregularly distributed, and sometimes clusters of white crystalline needles, or nodules of white crystals. Very frequently dezincification is very marked beneath the green deposit. The meaning of these appearances will be discussed later.

The corrosion with which we are concerned takes place in ocean-going steamships, in which the tubes are kept filled with sea water and so serve to condense the steam which surrounds them. The evidence is quite conclusive that sea water is the corroding agent, but its action may be accelerated or retarded by the presence of other materials and by the conditions under which the tube is placed.

Both copper and zinc are readily acted on by sea water under ordinary conditions and even at ordinary temperatures, and much more readily at higher temperatures. Brass, which is an alloy of copper and zinc, often with the addition of a small quantity of tin, is also acted on; but if of suitable composition, much less so than either of its constituents alone.

Sea water contains a considerable quantity of salts in solution, the one in largest quantity being sodium chloride, or common salt; it also contains, in solution, a considerable quantity of oxygen and of carbon dioxide. There is no doubt but that the oxygen in solution is largely responsible for the corrosion, and that the carbon dioxide plays some part in it; but the presence of this latter is by no means essential, as corrosion will go on, though at a reduced rate, when carbon dioxide has been completely removed.

The formation of the deposit found in corroded brass tubes, in so far as it is derived from the corrosion of the tube itself, is due to the combined action of the water, salt, oxygen and usually carbon dioxide, as is evident from its composition. In one case, the deposit from a corroded tube was found to have the composition:—

Copper oxide	30.85
Copper chloride	3.20
Zinc oxide	30.80
Iron oxide	11.40
Insoluble matter	3.08
Organic matter, carbon dioxide, water	20.67
	100.00

These figures are of importance, for they show that in this case at least the deposit is basic chloride and carbonate of copper and zinc. It contains copper and zinc in nearly equal quantities, though in the tube the metals were present in the ratio 7:3, so that it is quite obvious, as indeed will be demonstrated later, that the zinc is more readily removed from the brass than the copper. It should also be noted that there is a considerable amount of oxide of iron (as hydrate), insoluble matter, and organic matter, which could not have been derived from the tube itself, but must have been introduced from the outside. This is the case in every sample of deposit from badly corroded condenser tubes which I have examined.

A sample of the deposit formed by the action of clean sea water on copper was found to contain:—

Copper carbonate	29.77
Copper chloride	8.39
Copper oxide	59.38
Water	2.46
	100.00

A large number of experiments have been made on the action of sea water on various metals, but more particularly on brass, with special reference to this question of corrosion. Weighed pieces of metal have been exposed to the action of sea water, in some cases for many months, the water being frequently changed so that the action might not be interfered with by the removal of oxygen and carbon dioxide, which must have happened had the same quantity of sea water been used the whole time. Most of the experiments were made at the ordinary atmospheric temperature, but in some cases the tubes and samples were for some weeks heated to about 80° C. during the day and allowed to cool at night. It would occupy too much space and would hardly be of interest to quote results of the experiments in detail, but a summary of the results obtained with brass may be of interest. Taking first of all a brass containing 70 per cent of copper and 30 per cent of zinc, which is the usual composition of the brass used for boiler and condenser tubes:—

The action of sea water was very marked in every case, and as might have been expected was much more rapid when the water was heated. A green deposit was formed, exactly resembling that obtained from corroded condenser tubes. Sometimes this adhered to the metal, but at other times was quite loose. In some cases growths of white crystals of a zinc salt were noticed, exactly similar to those already mentioned as occurring in corroded condenser tubes. The zinc was always dissolved much more rapidly than the copper, but the proportion varies with circumstances. As a rule about five or six times as much zinc was dissolved as copper, whilst in the brass of course, the ratio was 3:7. The action is more rapid at first; the green deposit which forms on the surface of the metal, especially if it be adherent, seems to some extent to protect it from further action.

It will be noticed that if the metals were attacked in this ratio in the tube from which was taken the deposit, the analysis of which has been given, a considerable quantity of zinc must have been removed in solution or in suspension.

When the brass contains 66 per cent or less of copper, the action is very different; the amount of copper removed is small and the deposit is nearly white, consisting almost entirely of zinc salts. In a 66/34 brass tube the ratio of zinc to copper dissolved was 146:1 in one case and 214:1 in another, whilst with 50/50 brass, only a minute trace of copper was removed.

The actions by which a brass tube may be corroded are usually divided into three kinds:—

1. General corrosion, in which the copper and zinc are removed practically together (i. e., in the ratio in which they exist in the alloy) by chemical or electric action, the tube thus diminishing in thickness but otherwise being unchanged.

2. Dezincification, in which the zinc is dissolved more rapidly than the copper and thus a surface layer (or local spots of a material very rich in copper) is left.

3. Erosion, in which the metal is worn away by the mechanical attrition of the water.

Corrosion of brass tubes always primarily takes the form of dezincification—except, of course, in the case of erosion—the sea water attacking the zinc more readily than the copper, the copper being left in a spongy form, which is very easily worn away. Whenever the copper and zinc seem to be removed together—i. e., when general corrosion takes place—it is always because the spongy copper left by the dezincification has been removed by the mechanical action of the water aided by solid matter which may be in suspension, and this is why tubes which are worn away very uniformly show little sign of dezincification.

The question, however, remains to be answered:—"Why is the action so much more rapid in some cases than in others? Why is it that whilst in some cases condenser tubes will last ten years or more, in others they fail in a few months, or occasionally even a few weeks?"

Obviously the fault—if fault there be—or at any rate the reason must be in one of two places. It must either be due to something in the nature of the tubes themselves,.or to the conditions under which they have been worked. There is no alternative unless we assume some occult cause to explain the apparently erratic behaviour. Each view has its advocates, the former being favoured as a rule by engineers who use the tubes, but who are not familiar with the processes of manufacture, whilst the latter is the view taken by the manufacturer.

I hold no brief for either side; I have investigated the matter as fully as I have been able, both in the laboratory and by practical examinations of cases of failure, and I am quite familiar with the methods by which the tubes are made and the processes through which they pass before reaching the engineer who will use them.

The tubes are, as already remarked, usually made of brass containing 70 per cent of copper and 30 per cent of zinc, this being the mixture almost invariably specified. It is found to be as durable as any other, there being no advantage whatever to be gained by increasing the percentage of copper. A slight variation up or down has no deleterious influence, and of course an increase in the quantity of copper is not likely to be injurious. Any careless work on the part of the founder is likely to lead to a greater loss of zinc and therefore, to a slightly higher percentage of copper. Many specifications are quite unnecessarily rigorous in the variations in the ratio of the two metals which they make allowable.

The composition of the tubes is always uniform. The composition at the two ends is always the same, and there are no spots richer or poorer in copper. This has been proved by many analyses; but quite apart from that, the conditions under which the tubes are made render such variation well nigh impossible, and the idea that there may be spots or patches in a tube differing in composition from the rest, which might set up electrolytic action and thus give rise to local corrosion, whilst believed by many engineers, is not in harmony with facts. The coppery plugs or spots already mentioned have been thought by some engineers to be due to fragments of unalloyed copper left in the mixture. This suggests an impossibility; for the spots are always round, and a fragment of copper if left unalloyed in the casting—which is, however, impossible—would be drawn out into a minute thread in the process of drawing, through which the tube goes. These spots or plugs are of quite common occurrence in badly corroded tubes, though they are very often overlooked. The inside of the tube when taken from the condenser is usually covered with deposit; the outside is covered with grease; and it is not until these are cleaned away that the spots can be seen. The engineer as a rule is not concerned to make a minute examination of the failed tubes; he is anxious to get them away and to get new ones in their place, and hence unless there is some special question likely to arise, the tubes will not be examined and the spots will not be detected. These spots of copper are certainly due to dezincification, as also is the layer of copper sometimes found inside the tube, and the copper almost always retains a certain amount of zinc. In one case a fragment of a coppery patch from a corroded tube contained 3.7 per cent of zinc, showing that most of the zinc from the original brass had been dissolved away at that spot, and a specimen of dezincified layer from inside another tube contained 3.84 per cent. of zinc.

It is very doubtful whether the use of specially pure metals is any great advantage, though it is no disadvantage, and it is wisest to err—if at all—on the safe side; but the use of specially pure and, therefore, costly metals seems to entail increased cost without any corresponding advantage. Nothing in the chemical composition of the brass, if it be approximately 70 and 30, will account for the variations in the durability of the tubes. Indeed, it not infrequently happens that with tubes as far as can be detected in all respects identical as to composition and make, one set will wear well, whilst another will corrode with extreme rapidity.

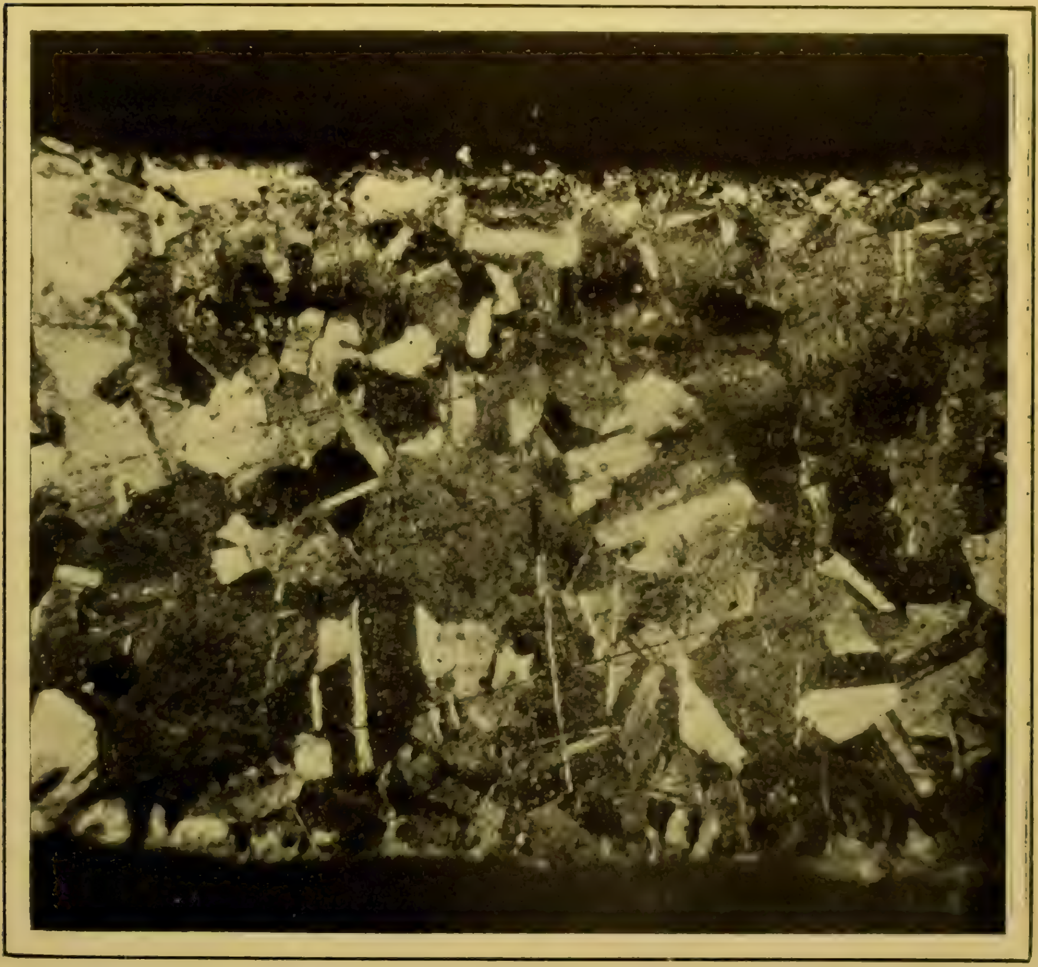


FIG. I. MICROSECTION OF BRASS CONDENSER TUBE, SHOWING COARSE CRYSTALLIZATION.

Magnified about fifty diameters.

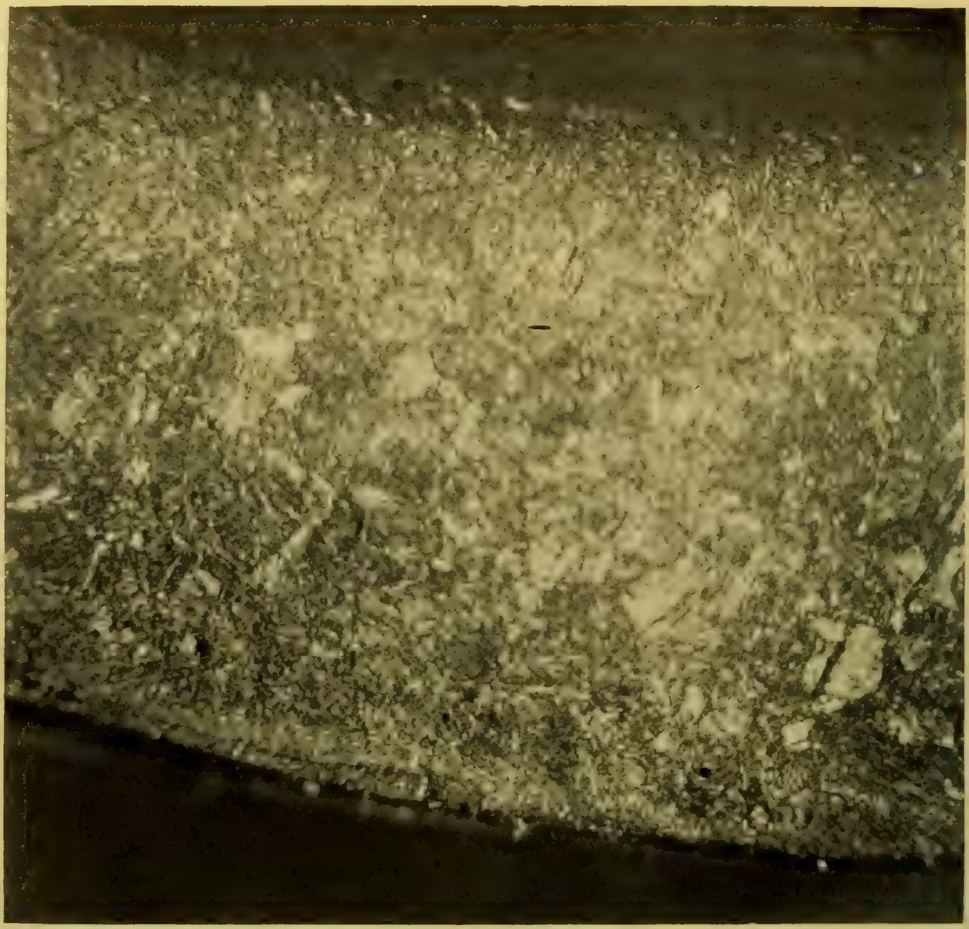


FIG. 2. MICROSECTION OF BRASS CONDENSER TUBE, SHOWING MEDIUM AND RATHER IRREGULAR CRYSTALLIZATION.

Magnified about fifty diameters.

The mechanical structure of the metal has sometimes been held to be responsible for corrosion. Brass containing 70 per cent copper and 30 per cent zinc is a homogeneous alloy. On cooling, it crystallises as a whole and does not separate into two constituents as the poorer brasses do. It behaves in this respect as if it were a chemical compound, but that it is not a true compound is shown by the fact that the elements are not present in simple atomic ratios, that the composition may be varied within wide limits upwards, and to a small extent downwards, without altering the structure, and by many of its chemical reactions. It crystallises as a whole and forms a homogeneous crystalline mass. In the casting the crystals are very large and distinct, but they are broken up during the drawing, and are re-formed when the metal is annealed. The actual size of the crystals in condenser tubes varies very much, the difference being probably due to variations in the time and temperature of annealing. Figures 1, 2, and 3 are microsections of brass condenser tubes magnified about fifty diameters. It will be seen that the size of the crystals is very different in the three cases. This difference in the size of the crystals may have a profound influence on the physical properties of the metal, but has no influence whatever on its resistance to corrosion.

It has been suggested that the crystals being differently oriented might set up galvanic action, so that the lines of junction of the crystals might become centres of corrosion. There is no evidence whatever in support of this idea; and even if it were true, it would not account for the formation of pits and corrosion patches a considerable distance apart. I have found that dezincification bears no

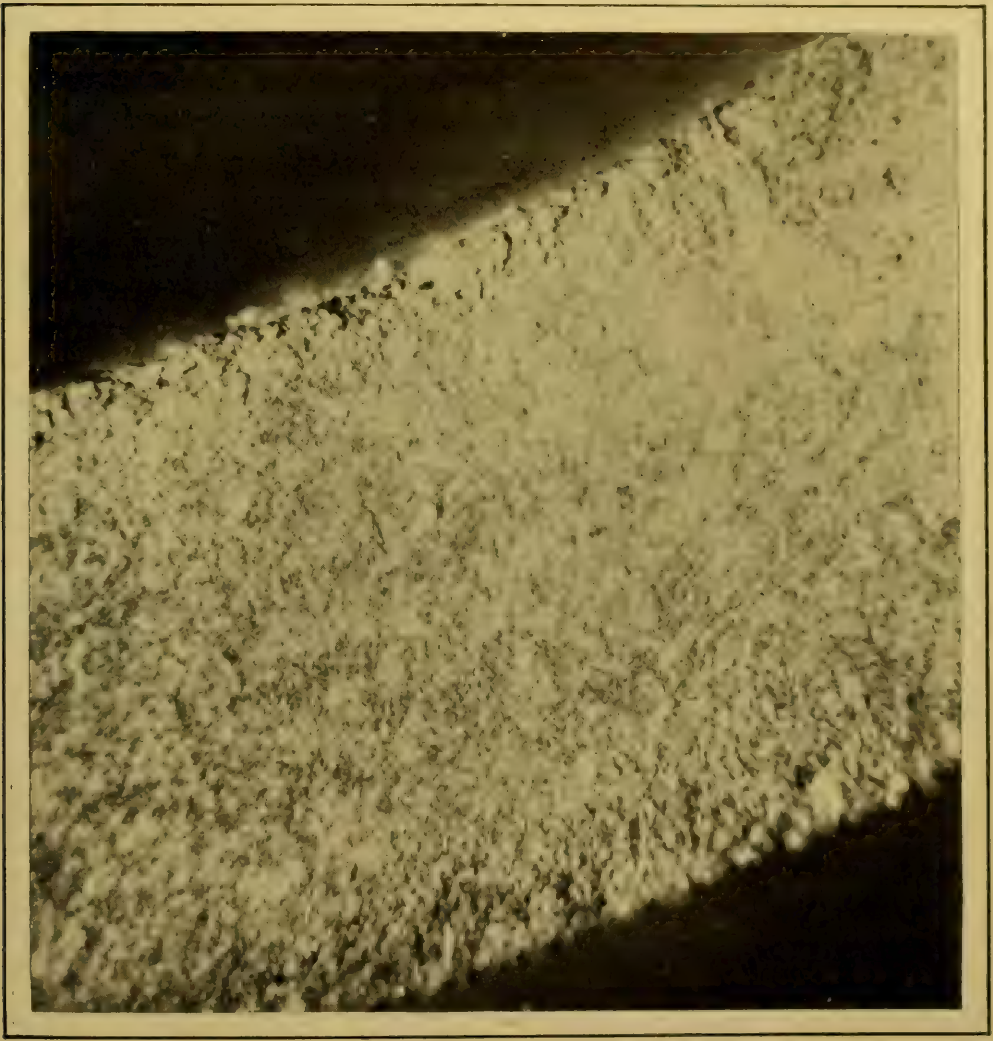


FIG. 3. MICROSECTION OF FINELY CRYSTALLIZED BRASS CONDENSER TUBE. FIFTY DIAMETERS.

relation whatever to crystal structure, the line of action as often passing right across a crystal as round its margin.

It has been contended also that the larger the crystals the more rapid will be the corrosion. This, however, is certainly not the case. I have found that the size of the crystals has no influence whatever on the corrosion of the metal. A very large number of corroded tubes have been examined and it has been found that good and bad tubes—the quality being measured by the amount of corrosion that has taken place—are impartially distributed between those with a coarse, medium, and fine structure.

Among methods that have been suggested for increasing the durability of condenser tubes may be mentioned the addition of a small quantity of tin to the alloy. The British Admiralty, for instance, uses an alloy which contains 70 per cent of copper, 29 per cent of zinc, and 1 per cent of tin; but it is very uncertain whether this is any material advantage. The coating of the tubes with tin has also been tried, but the protective action, if any, is very small. I am convinced that for this particular purpose nothing is better than 70/30 brass.

I feel quite certain that the cause of variation in the durability of condenser tubes is not to be found in the chemical composition or physical structure of the metal, nor in any variation in the process of manufacture, nor in anything connected with the tubes; indeed, the tube-maker, while keeping to the specified composition and passing the tubes through the usual tests for soundness, could not, if he tried, turn out a tube specially liable to corrosion. This is, of course, not the usual opinion of engineers. They say: "Here are two steamers working under exactly similar conditions, and whilst in one the tubes have stood well, in the other they have corroded very rapidly; therefore, the reason must be in the quality of the tubes." This dilemma may, however, be put in another way. Here are two steamers fitted with exactly similar tubes, selected haphazard out of one large parcel; in the one steamer the tubes have stood well, whilst in the other they corroded rapidly, therefore there must be a difference in the condition of working. The latter is certainly the correct view, for there are so many possible variations in the conditions of working that it is impossible to decide when these are uniform. Two steamers moored at the same berth on a river may be under very different conditions, and so in many other ways there may be differences of condition which, together with differences in the way in which the condenser is treated by the engineers in charge, may account for the differences in the corrosion of the tubes.

The solvent action of sea water will account for the slow and steady dezincification which will ultimately wear away the tube; but this will take years, and something more is necessary to explain the irregular corrosion which is so destructive. The corrosion into holes in particular spots seems to indicate some local cause, and at once suggests electrolytic action, the tube itself being the anode; but if this is the case, the difficult thing is to find what can be cathode. It must obviously be some substance strongly electro-negative to the brass.

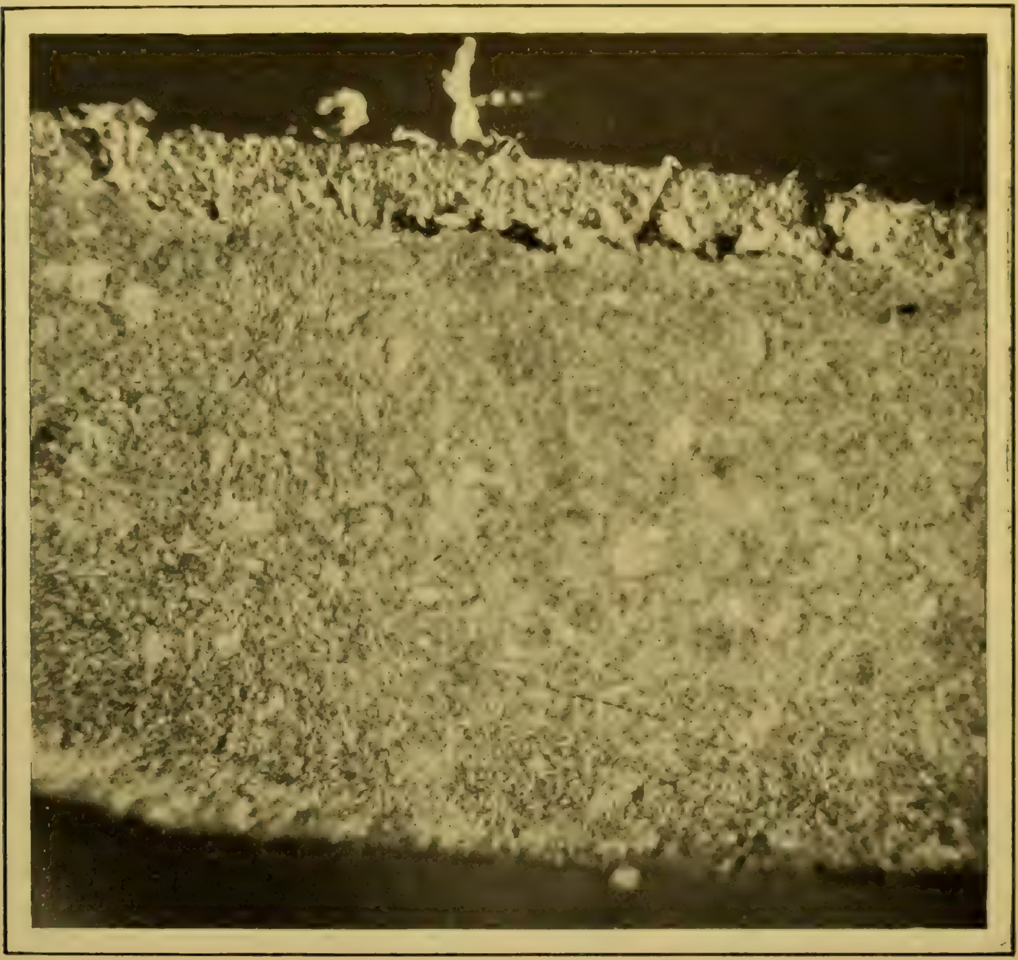


FIG. 4. CONDENSER TUBE, SHOWING LAYER OF DEZINCIFICATION. FIFTY DIAMETERS.

Many experiments have been made as to the influence of the contact of various substances with 70/30 brass—pieces of condenser tubes being used—immersed in salt water, and though the results obtained are not new, they tend to throw some light on the subject under discussion.

Malleable iron and zinc in contact with the brass, as might be expected, completely protect it from corrosion, being strongly electro-positive to it; on the other hand, when a fragment of graphite was placed on the metal, a well marked spot of dezincification (i. e. copper spot) was formed beneath it. The spot was, of course, only superficial, the length of time the experiment was continued not being sufficient to allow the action to go on to any depth. With a piece of coke an exactly similar result was obtained. In both cases the action was more marked when the water was heated. A layer of blacking, which is nearly pure carbon, increased the action of sea water, and also increased the ratio of zinc to copper dissolved. Similar results were obtained with other substances. The green oxychloride of copper seems to protect the copper, and thus to increase the ratio of the zinc dissolved. Ferric hydrate is stated by Professor Tilden to cause rapid corrosion. With a fragment of iron scale, dezincification under the scale was well marked, but copper scale has no such action.

Foul river water has been accused of causing rapid corrosion, and it may be admitted at once that there are many cases of rapid corrosion in the case of steamers plying alternately on such waters and on the sea—perhaps more than on steamers plying only on the deep sea; on the other hand, in many such steamers the tubes last quite the normal time. It will, of course, be admitted that acid waters will be likely to increase corrosion considerably, though 1 per cent sulphuric acid has little more action than sea water; in any case, the action of an acid water would be expected to be nearly uniform, and whilst it might accelerate corrosion, would hardly be likely to cause pitting. It is only in very exceptional circumstances, as for instance when acid refuse is discharged into a river, that the water will be sensibly acid.

Brass tubes exposed for four months to Clyde water—and the Clyde is not regarded as the purest of rivers—taken from the Broomielaw, did not lose seriously in weight, but only became tarnished by the formation of a dark layer, apparently of copper sulphide. Some samples of brass tube were moistened with ammonium sulphide so as to produce dark stains of copper sulphide, and were then put into sea water. The action was at once very marked, the ratio of zinc to copper dissolved being increased to 16:1 per cent in one case and 12:1 per cent in another. It would seem, therefore, that a river water containing sulphides might cause a deposit of sulphide which on the tubes being filled again with sea water, would set up corrosion and this being repeated day after day, vigorous corrosion might result.

Other suggestions have been made, as for instance, that the corrosion may be due to electric currents, from the electric lighting or other electric plant on board ship, especially where the single-wire system is used. This may be an occasional cause of corrosion, but I do not think it is at all frequent. It is difficult to see how stray currents can find their way into the condenser, so as to cause electrolytic action. In a paper read before the institution of naval architects on April 3, 1903, Mr. A. W. Stewart describes the corrosion of copper bilge suction pipes on certain steamers of the Russian volunteer fleet, and he comes to the conclusion that in this case electric currents had nothing to do with the corrosion. Corrosion does not seem to be more common in steamers with electric fittings than others, nor does it seem to have increased since the use of electricity became common.

In the above mentioned case, Mr. Stewart ascribes corrosion to the presence of oils and grease. But it is obvious that this is not likely to be the case inside condenser tubes, where grease or oil could not ordinarily find its way. Corrosion on the outside of condenser tubes, which is usually on a small scale, is no doubt often produced by oil or grease carried over by the steam.

I have come to the conclusion that rapid and irregular corrosion, as distinguished from that due to the normal action of sea water, is almost invariably due to electrolytic action set up by the contact of particles of substances electro-negative to the brass, probably in most cases carbon.

Where can these particles come from? Frequently they may come from outside, especially if the water be drawn from such a position that cinders thrown overboard may be drawn in with it; and cinders have actually been found in corroded condenser tubes. In some cases particles may be derived from the cast-iron doors of the condenser itself, if these are not well protected. A fragment of cast iron would be rapidly oxidized, and for a time would act as a protective agent, but as soon as the iron was dissolved the particles of the residual spongy mass, consisting mostly of graphite, would be electro-negative to the brass and would cause rapid corrosion. If the iron of the door rusted, the graphitic mass would be easily detached, and might be carried into the tube. As already remarked, the corrosion spots usually lie in a line along the bottom of the tube, this indicating that they have been caused by something which settles there. It is also noteworthy that the deposit in corroded tubes nearly always contains a considerable quantity of oxide of iron, which must have been derived from some external source. When a steamer plies on a foul river, the conditions are much more likely to lead to corrosion than on the open sea. On such a river as the Clyde, cinders and fragments of charcoal frequently float on the surface, and may readily be drawn into the condenser. The water may contain sulphides, as evidenced by the very strong odour of sulphuretted hydrogen that may often be detected, and thus patches of sulphide may be formed which may subsequently set up action. Sticky organic and oily matter may frequently be present, and these, though they may have no direct action, may cause the adherence of particles which may in their turn lead to corrosion, especially when coming in contact with sea water. Indeed, the composition of foul river water is so complex and variable that it is difficult to say what action may not take place. The conditions also of such a river vary much with the seasons and other circumstances. In time of drought, when the water is low, it will be more strongly charged with impurities than in times of rain when there is abundance of water. The discharge of acids and other impurities from works is not continuous, but takes place at intervals only, and there may be variations even from hour to hour; and even if the conditions are the same, the state of the tubes as to deposit, and other conditions, may much modify the action.

As to the cure for irregular corrosion, there is none—at any rate after it has made progress; but like many diseases, if it cannot be cured, it can be prevented; and I am strongly of opinion that it is always preventable.

1. The corrosion from the presence of solid particles can take place only if such particles are allowed to rest in the tubes. If the current be strong, therefore, corrosion is little likely to take place, while if it be sluggish, corrosion is very probable. Should a tube become partially stopped for any reason, that tube is specially liable to corrosion. Sluggish circulation is a very common cause of corrosion.

2. The tubes must be frequently cleaned, so that any deposit which is forming may be removed. This is of special importance in steamers running in foul rivers which may readily pick up substances which may cause the adhesion of objectionable material.

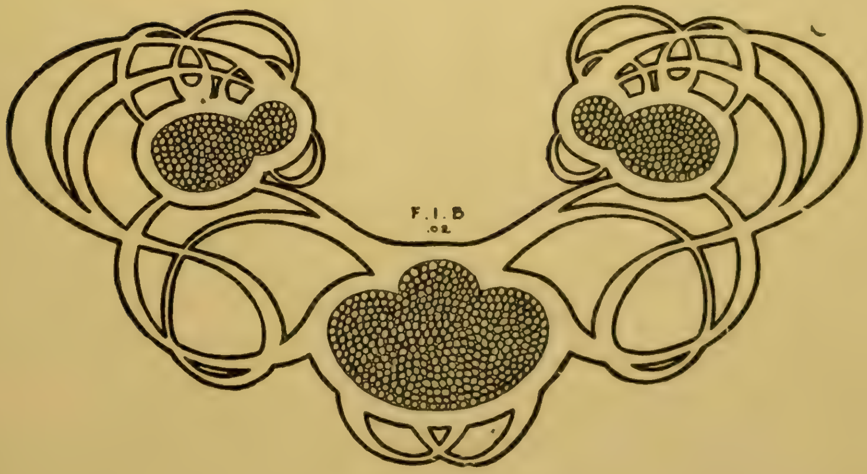
As has been pointed out, tubes that have corroded badly are almost always characterized by the presence of a heavy deposit.

3. The tubes should never be left full of water when the steamer is at rest, but should be run dry and perfectly washed out with clean water, as soon as the day's work is done. This, too, is of special importance in steamers running on foul rivers where objectionable matter may be drawn in, which, during the period of rest, will settle to

the bottom of the tube and form a lodgment from which it will not be displaced when work is resumed, and so corrosion may be set up, and once started it will go on rapidly under the deposit formed.

In conclusion, I am quite convinced that if the condensers be well designed and these precautions be taken, very little will be heard of unduly rapid corrosion, but that unless such precautions are taken the tubes will always be liable to erratic and rapid decay, and the conditions being entirely beyond any power of calculation, no estimate or guarantee can be given as to the probable life of a tube.

Some of the experiments cited are only tentative, and perhaps some of the conclusions may not be fully proved; but I feel quite sure that on the whole they are sound and in the right direction. I will be much obliged if engineers and others who come across cases of corrosion which either bear out or tell against these conclusions will communicate with me and send samples of the corroded tube, deposits, and anything else that may help to complete the investigation of the causes of the corrosion of condenser tubes and other underwater fittings on board ship.



STEAM BOILERS OF THE PAST AND THE PRESENT.

By Egbert Pomeroy Watson.

Mr. Watson's discussion of his topic has the vitality which springs from his lifelong association with the making and the working of steam boilers. He has been among those who made the experience which has found formulated expression in modern practice, and in his article the reader will find himself following the successive steps of development in the art, with a clear understanding of the environment and of the spirit of the earlier steam engineers and constructors. Beyond this, Mr. Watson gives a very lucid explanation of the difficulties which confront the steam user and the boiler tender, and of the effective remedies.—The Editors.

COMPARISONS between the splendid steam generators of the present and the same apparatus built by our grandfathers would be unfair, unless the conditions under which both were built are taken into account. We have now a material—steel—which is ideal for the purpose and will stand an amount of fatigue under stress and distortion that is astonishing, commanding the admiration of men who are not usually enthusiastic about anything. Its endurance under flanging into any departure from a flat sheet is remarkable, there being, apparently, no limit to the punishment ti will stand without "crazing" or showing weakness of any kind. Modern open-hearth steel can be fashioned into all sorts of shapes and retain its elasticity and homogeneity throughout.

Modern high pressures were impossible in the early days of boiler making, for want of material; but we think no more now of constructing generators to carry 250 to 300 pounds per square inch, than we did fifty years ago of expecting them to stand less than one-fifth of that pressure, not feeling at all certain even then that some flaws did not exist in the sheets which could not be seen externally.

It is not asserted that good material for making steam boilers did not exist half a century ago, but that it was not always used for that purpose is undeniable. Tests of American plates made prior to 1860 show a tensile strength of 66,000 pounds, or more than the average boiler steel of today; this was charcoal iron, of course, and was sometimes bloomed and in other cases puddled; but even this was not uniform in quality, depending (as it did) for accuracy of observation as to the critical point by the workman in charge. The searching analyses of the present day were not generally practised by the manufacturers of 1850; they were not unknown, however, for I find by reference to a treatise of the period named that the same elements which now are expurgated, so to speak, are adverted to and called "impurities." Sulphur, phosphorus, silica, arsenic, etc., were known to work mischief.

In half a century great progress has been made, not only in better processes but in material as well. Necessarily much had to be learned in this direction; everything was lacking. Precedents, procedure, tools, and the "know how to do it," which last is a great element in succcess. We might with as much propriety deride the efforts of a child learning to walk as to compare the steam generators of half a century ago with those we now build. Success and failure are alike founded upon the mistakes of others.

By trial and error, those inexorable teachers, we have at last arrived at a point where we can predict with some approach to certainty what the action of certain forms or types of boilers will be, always excepting variations and departures from standard types with the same details differently disposed. Such a modification is supposed to constitute a new boiler, when the facts are that the only difference between it and well-known forms is that the arrangement of the heating and water surfaces, or their disposition with relation to one another, has been altered; this makes a vast difference in the working and general behavior of the apparatus as a whole, warranting the assertion that nothing can be predicated of the action of a new boiler. One of the most successful boilers in the market today has been built for years as a stationary boiler, but the proprietors introduced it for marine purposes and for a long time met with every kind of disappointment in regard to its performance; nevertheless by constant experimenting at an enormous expense they were able to locate the causes of erratic behavior, and from a failure in its new sphere to remodel it into a generator of high efficiency. Most new boilers have a certain facility of steaming and an apparent accessibility for cleaning and repair, but it is only after months of actual service under varying conditions that they reveal their weaknesses; after the heating surfaces have become foul with scale and soot, with innate depravity, perhaps, it shows an obstinate determination to fill up in the most inaccessible spots. Expansion and contraction were the two forces which gave our forefathers the most trouble, and they are by no means overcome yet. The parts give and they take, "but one event happeneth to them all"—complete disruption of the connected portions, eventually, unless the result is forestalled and prevented by compensations provided by the designer.

A feature of marked value in certain types of modern steam boilers is the rapidity with which they generate steam, vying in this direction with steam fire engines. Considering the water content of both types, the marine boiler of the present is even superior, pressure for pressure. It is easily possible to generate 250 pounds of steam from cold water in a 1,000-horse-power marine boiler in ten minutes without injury to any part; and these are not torpedo-boat boilers with one inch tubes, but battle-ship boilers holding, in many cases, more than fifty tons of water; compare this with the fire-engine boiler, holding a barrel or two of water only, and the marine boiler does not suffer by the contrast. Not all marine boilers are capable of steaming with the facility mentioned; there are still a large number in use which require hours instead of minutes to get a working pressure; the fact remains, however, that, by and large, the sluggishness of steaming peculiar to the boilers of half a century ago has been removed to some extent, and wholly in the special types mentioned.

Circulation in steam boilers is either natural or artificial; in the first instance the water is carried over the heating surfaces in regular sequences; in the latter it is arbitrarily forced in contact with them by pumps or their equivalent. In some types of boiler there is no large body of water present—the flash-boiler, for example—and there is no circulation except that given by the incoming jet; this is not a true circulation for the reason that the water does not come in contact with all of the hot metal. Where the jet strikes first the water is immediately vaporized in whole or part; that which is not falls to the bottom; if the heating surfaces are in coils the water never gets to the bottom of it as water, but in the form of steam, and the heat which is in that portion of the coil is lost or dissipated in reheating the steam—desiccating it, as one may say. True circulation in a steam boiler is that which, under the influence of heat causes the water to traverse the line of least resistance, covering all the hot surfaces as it goes, moving in a direct line for the drum, or whatever reservoir is provided for the steam. Where this kind of circulation exists the boiler is a quick steamer, and the products of combustion go into the funnel at very low temperatures—so low, in fact, that they cannot evaporate water, no matter how much heating surface there is yet to be traversed. It is for this reason that superheaters placed in uptakes intended to high dry steam fail to do so—the spent gases are too cold. The steam made by boilers with poor circulation is inferior in quality in that it holds more or less water in suspension. This is a fault of the design, for watery steam is adulterated steam, which must be strained before it can be used economically. The dispersion of the water is accomplished by apparatus of one kind or another which is called a separator, and it performs a double office, to wit: separating the steam and water, and separating the steam user from his money beyond recourse. No part of the water heated to the boiling point and then thrown away through the separator is ever recovered. It is a total loss, of considerable amount where many separators are in use. Two per cent. is a very moderate amount of moisture held in suspension in steam; the average in very faulty boilers is much more; it is easy to estimate what amount of water is turned into steam and then thrown away in large steam plants by boilers which have poor circulation and resort to separators as a remedy for it.

A dry pipe is a much better remedy for a foaming boiler than a separator—when the dry pipe is properly made. In most of them the holes are too large. I have built a good many boilers where the water line was within six inches of the steam outlet—very rapid evaporators, too—but I never had a drop of water drawn into the steam pipe, the reason being that the steam-holes in the pipe were made with a No. 60 twist drill. These boilers ran perfectly for a long time with very bad water, but they never scaled over or stopped up. Most dry pipes, or very many that I have seen, are drilled with 3-16-inch holes. This is no bar to the passage of water and steam mingled, but dry pipes have been condemned as useless because they were not properly made. The losses by wet steam do not, of course, end with loss of heat, but this is another branch of steam engineering which need not be considered in this connection.

Probably no apparatus used in the arts suffers so much from ignorance and abuse by carelessness upon the part of both owner and engineer as a steam boiler. Neglect is the rule rather than the exception. There are no working parts about boilers; they never protest audibly, as engines do by pounding or other external evidence of internal distress, but they waste away by slow degrees until they are no longer safe to use. Parsimony and ignorance are the causes of this—the first on the part of the owner and the second on the part of those in charge. It would seem as though any one fit to be about a boiler could not help remarking that the water which is used for making steam carries more or less dirt with it which should be removed frequently, but, aside from this, the mineral matter held in suspension in the water is the most serious point to be considered. The average man is not supposed to know this; he feels that scale, even when he knows that there is such a thing, is a natural consequence and unavoidable—an act of God, as it might be called, for which he is not responsible and against which man strives in vain. If it were possible to reach all inexperienced persons in charge of boilers and point out to them by word of mouth that by care at the proper time they can in a great degree prevent scale from forming, there would be a change for the better and boilers would last longer. Ask them to consider the fact that water holds from 40 to 60 grains of solids to the gallon (not inclusive of free dirt) and that a 60-horse-power boiler should evaporate at least 1,500 pounds of water per hour, 15,000 pounds in a workday of ten hours; that in one pound avoirdupois weight, sixteen ounces to the pound, there are 7,000 grains—and then consider how long it would take to fill a boiler up chock-a-block with refuse unless it is removed in some way! Examples like these would be understood by even unlettered men, but the difficulty resides in the fact that such persons seldom read and cannot be reached. A remedy for loss and injury to boilers lies in the expectation that steam users will read and see for themselves that their plant is properly cared for.

Aside from the damage incurred by scale, which is simply matter in the wrong place, there are a large number of evils boilers are heir to, which unless prevented tend to shorten their lives and are a source of expense to the owners of them. These defects are here enumerated:—deposits of free dirt; incrustation and scale; internal grooving; external grooving; internal and external corrosion; broken and loose braces and stays-bolts included; bad settings; distorted furnaces (crown sheets down); cracked plates; burned plates; blistered plates (baggings in shells over the fire of return tubular boilers); bad riveting; defective heads; serious leakage around tube ends; defective blow-cocks; shortness of water; overloaded safety valves; bad safety valves; incorrect steam gauges, fast or slow; besides many other minor matters that need not be classified.

Of these causes of deterioration, by far the most numerous are those arising from the presence of scale and its twin sister, incrustation; but broken braces can give an engineer a very bad quarter of an hour. A steamer plying on the Great Lakes many years ago carried very high steam for those days—50 pounds per square inch on a very large and light shell. The engineer on watch was down in the fireroom looking around when a loud bang came from one of the boilers. Instantly divining the cause he looked questioningly at the head water-tender, who replied: "Be jabers, I hope that ain't next-door neighbor to the one that let go on the other watch."

That startled the engineer, for he had not been told of the other broken brace; he at once stopped the blowers, opened the doors, shut the stop-valve between boilers, and put on the feed pumps as rapidly as they could go so as to reduce pressure. The deck department was notified that it would be necessary to stop, and they hauled to one side of the channel and waited for the coming up of another boat in the same line passed a few miles back. The passengers (there were 1,000 on board) and mails were transferred, and the boat returned with the injured boiler out of business. Upon examination the next day it was found that three braces had given away at or near each other, two letting go simultaneously, apparently, and that the precautions taken against a disaster (which would have been terrible if it had occurred) were none too soon. This was merely an episode within the everyday duty of an engineer, and carries its own warning.

Within the last decade a new peril to steam boilers has been detected, giving engineers great anxiety, and for a while, baffling all investigation as to its cause; this is oil finding its way into boilers, and the results of it. I have said the last decade, but time flies so fast that it is much nearer twenty years since this danger became a serious menace to steam navigation; it is so insidious in its attacks that after a furnace has been forced down, distorted in grotesque shape, the closest examination upon the steam side of the furnace fails to show what caused it. Furnaces that are apparently without scale, and to which water had clear access, have been bagged time after time in different ships, so that as one engineer said to me "I am afraid to open a furnace door for fear of what may have happened since the last time I was around." The mischief mentioned happened chiefly to marine boilers, but stationary boilers were also injured, though not to so great an extent, for the reason that they were mostly non-condensing, while the larger number of bagged furnaces occurred in connection with surface condensers and high pressures.

The evil mentioned was so great twenty years ago that it almost caused a panic among marine engineers, because its origin was so obscure that no amount of care and attention seemed able to prevent it. At this stage of the trouble vessel owners abroad called in an English engineer, Mr. Vivian B. Lewes, F. R. S., to investigate and report upon the cause and cure of collapsing furnaces. Mr. Lewes appreciated the difficulties before him and set about a solution of them in a systematic way. His report was an extremely valuable one of great length, but no more than a mere outline of it and his findings can be given. Practical men in all branches of the business welcomed it and carefully studied his conclusions from cause to effect. In brief, the cause was the presence of oil on the heating surfaces which failed. When this was announced it seemed anomalous, from the fact that there was no ocular proof that it was a correct finding. There was nothing on the water side to substantiate Mr. Lewes's verdict but closer investigation showed that he was right. The oil used in the cylinders was a patented article stated not to boil under 370 degrees F.; as this was higher than the steam-pressure temperature corresponding to 80 pounds. It was deemed perfectly safe, in that it could not have been deposited on the heating surfaces and then distilled off leaving no trace. The oil was experimented with and found to boil at 248 degrees F.; thus reopening the question as to whether the oil had not been vaporized when the boiler was at work. This was the fact, despite the negative testimony of the furnace crowns, which were still covered with a slight coating of scale that had not been disturbed; but deposits from portions of the shell below the furnaces were extremely greasy, forming in connection with the free dirt and mineral precipitates an agglomerated mass which adhered tenaciously to the plates wherever it struck them. If this happened to be the furnace crowns with an intense heat beneath, the adhering deposit was changed into a spongy, leathery mass, originally a mere film, but soon blown up into a pancake form from which the oil rapidly distilled, leaving the viscous body behind in a pulverulent form, which disappeared wholly with the distortion of the furnace shells. To prove still further his diagnosis, Mr. Lewes took a portion of the deposits in the boiler and covered sheet-iron vessels with them in the form of a wash, and on subjecting such vessels to a high temperature readily burned a hole through the bottoms of them, showing that the coating was a perfect non-conductor.

Having established the cause, Mr. Lewes set about a remedy which would prevent such occurrences in future; this was, in brief, to introduce the feed water through a long pipe filled with coke in lumps, which caught the oil globules and prevented them from entering the boiler. This, in one form or another, is the practice of today; not only is the feed water filtered, but very much less oil is used than was the case many years ago; so lavish was its use then that boiler inspectors have told me that they have opened boilers which fairly reeked with oil, so much so that when the lower hand-hole plates were removed oil dripped from the tubes. My own experience would corroborate this condition, for, although I have never come across anything quite so bad as that described above I have seen men pour about a pint of oil into cylinder cups at frequent intervals, most of which was of course blown into the heater with the first exhaust.

Sight-feed lubricators have changed this state of things, but there are places where they are not used, or, if they are, they feed too fast. Many persons in charge of steam plants will not use any oil in the cylinders, employing plumbago as a lubricant in lieu of it. This is mixed with water and fed into the cylinders at stated times, but the practice is far from being general, possibly from the fear that the cylinders may be scored; where the packing is of the snap-ring type this is not likely to occur, but if it is jacked out hard against the cylinder walls there is some danger of a catastrophe.

No consideration of the great improvements in boiler practice during fifty years last past would be complete or so clearly recognized without illustrations of the boilers then used. We can see how we groped in darkness, so to speak, for want of precedents. We know now that it was not a superabundance of heating surface that made a lively boiler, but other things in connection with it. The proportions of grate surface to heating surface have not been changed, and science, pure and simple, has not laid down any formulæ which work better than our old rule of thumb. One of the latest text-books, written by a foreign engineer, alluding to this point, says that in the rules furnished the author has endeavored to give the latest discoveries in the science of steam engineering, but has found himself somewhat hampered by their close relation to "empirical practice!"

That is very neatly expressed, and is correct in the sense that a steam boiler is not an invention, but an evolution from certain hard facts and premises, forced upon us by the incontrovertible argument of failure under present conditions; these last being that in the early days we built boilers that did not perform to our liking, and were compelled to go on building them until they did. Trial and error was empirical practice, but we had no other resource, being compelled to blaze our own trail as we went along.

It should not be called empirical practice, or the rule of thumb, which is only a synonym for guessing (success in which resides in the skill of the guesser) but rather, a close diagnosis of the apparent facts, which can be shown correct or the reverse by the immediate results. Failures are beacons, erected upon mechanical shoals to warn off all wayfarers who may have to pass that way.

For manufacturing purposes the boiler shown in Figure 1 is a fair example of the type used in 1850. As will be seen, it is a drop-flue boiler bricked in, of the dimensions shown in the diagram. The grate was very large for the heating surface, having 19.25 square feet to a total heating surface of 379.45, a ratio of 19.7 to one; notwithstanding this the boiler was a very poor steamer, evaporating only 4.7 pounds of water per pound of coal, and, per pound of combustible, only 5.87 pounds of water per pound of coal. The pressure in the boiler above the atmosphere was 30.7 pounds.

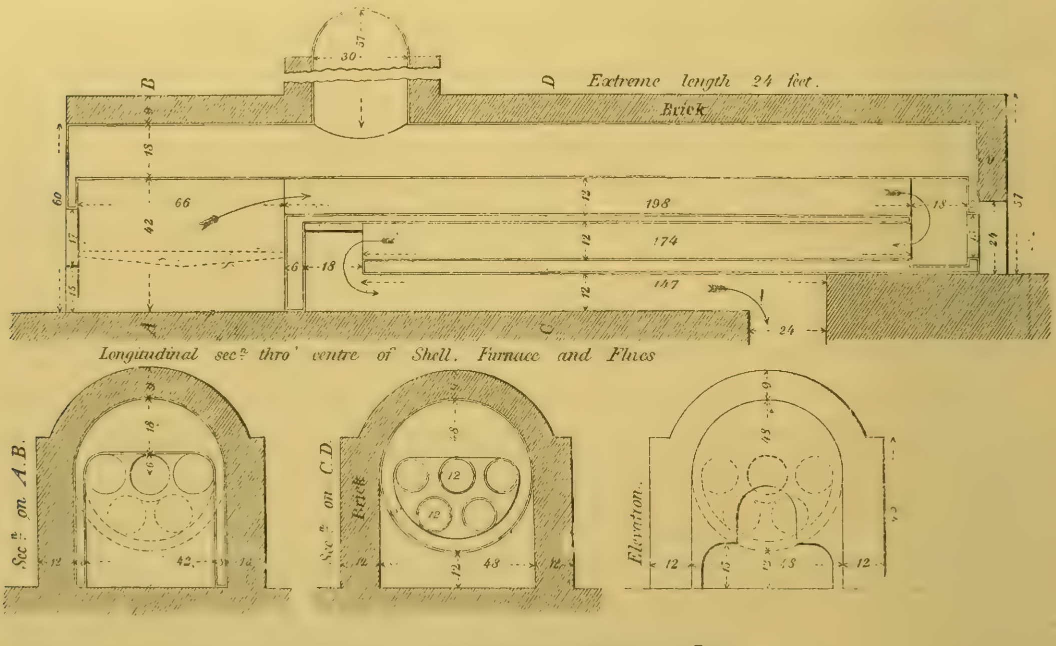


FIG. I. A TYPICAL BOILER OF 1850.

Figure 2 shows another form of stationary boiler which is a very close approximation to the return-tubular type in general use at the present day; with the exception of the circulating pipes at the water line it is a return tubular boiler pure and simple. These circulating tubes (as they may be called) serve merely as conduits to admit water to water legs extending the whole length of the boiler, a sort of return circulation being obtained through the depending tube entering the pipe connecting both legs just behind the bridge wall. This boiler gave very good results for the day and time, evaporating 9 pounds of water per pound of coal from a temperature of 100 degrees F., and 11.57 pounds of water per pound of combustible from and at 212 degrees F., in spite of its poor circulation, chiefly local. The temperature in the smoke stack was only 500 degrees F., showing that the heating surfaces acted very efficiently.

The present return-tubular is a popular form of fire-tube boiler for the reason that it is simple to make, steams well, and is easily managed by any person fit to be about a boiler at all; but it has the great drawback of requiring a brick setting, which is not only expensive but needs frequent repairs; it is also difficult of access for thorough inspection and overhauling, but it is more used than any other type, excepting, possibly the vertical tubular.

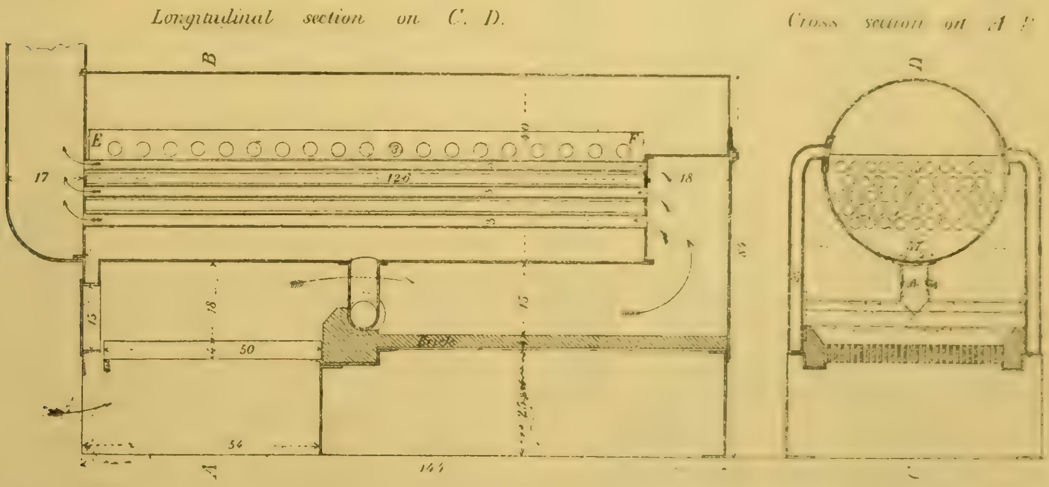


FIG. 2. A PROTOTYPE OF THE MODERN RETURN TUBULAR BOILER.

Mention of this type recalls one invented by an English engineer in 1846; it was reinvented by Thomas Prosser of New York in 1855-6, and again redesigned by Lee and Larned, also of New York, for steam fire-engine purposes. The original boiler was put into an English tug-boat, where it more or less promptly blew up, with what is described as an enormous pressure, to wit—100 pounds per square inch above the atmosphere! It so happens that when Lee & Larned built the boiler at the old Novelty Iron Works in New York I was employed there, and saw these boilers under construction. On one occasion a boiler of this type was standing in the yard under pressure when a workman came along and stopped to examine it; he cast his eye upward and saw that the gauge registered 240 pounds to the square inch and "stood not upon the order of his going" but fled to the uttermost parts of the yard, expecting momentarily to hear the report of an explosion. He never heard it, for that was the working pressure which was always carried; the boilers were strong enough, but wholly impracticable in other respects. A glance shows that the boiler is inaccessible for cleaning, and very difficult to make and keep tight. If a tube leaked no one could tell which it was, and the boiler was immensely expensive to construct. It was a combined fire and water-tube boiler, the water-tube being inside the fire-tube with only a quarter-inch water space. It was a rapid steamer, getting a working pressure from cold water in five minutes, but it had the disagreeable habit of collapsing the water tubes in considerable numbers every time it was put to work. Quite a number of these boilers were built and used, but there was great opposition to steam fire-engines in those days, and the volunteer firemen refused to act with them. When they were compelled by force of public opinion to adopt some form of steam fire-engine it was not the Lee & Larned. The boiler was emphatically a freak, of no practical utility.

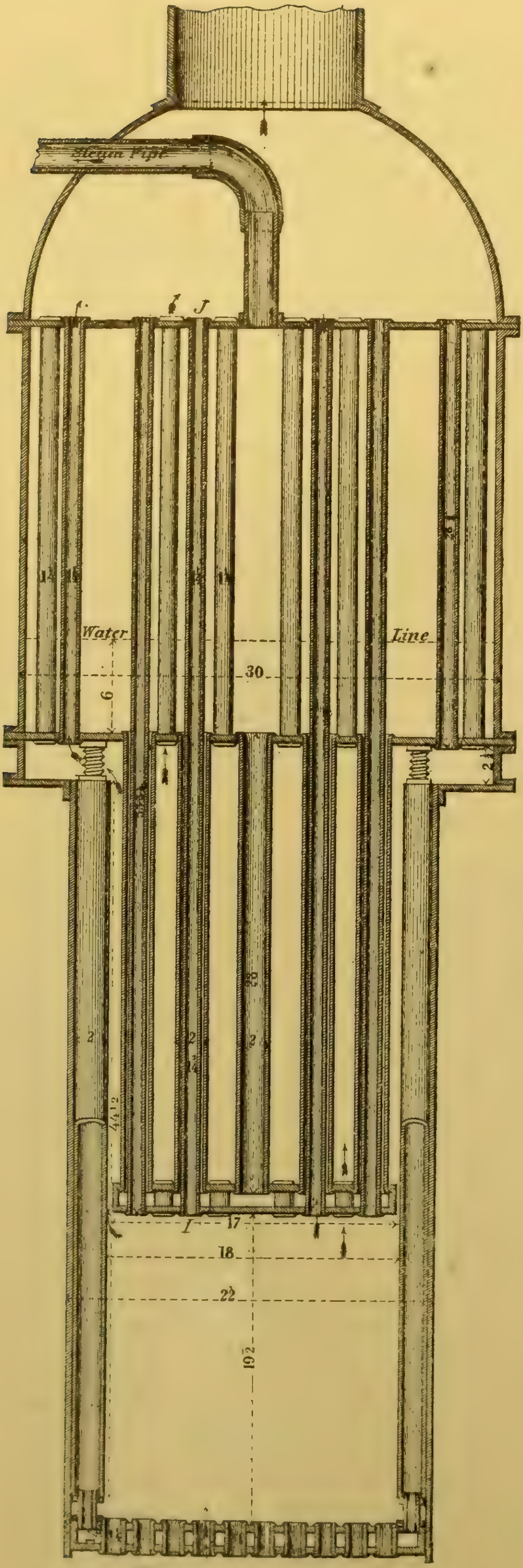


FIG. 3. MULTITUBULAR BOILER OF 1846.

It is interesting to note the progress of the water-tube boiler pure and simple, in the last twenty or thirty years. Asking a steam user to buy a boiler of that kind fifty years ago was looked upon almost in the light of an affront. And yet the type is a very old one. The British Museum has one that was found at Herculaneum which was used for heating water in a public bath; it is identical with modern boilers in general use which have horizontal water-tubes taking into

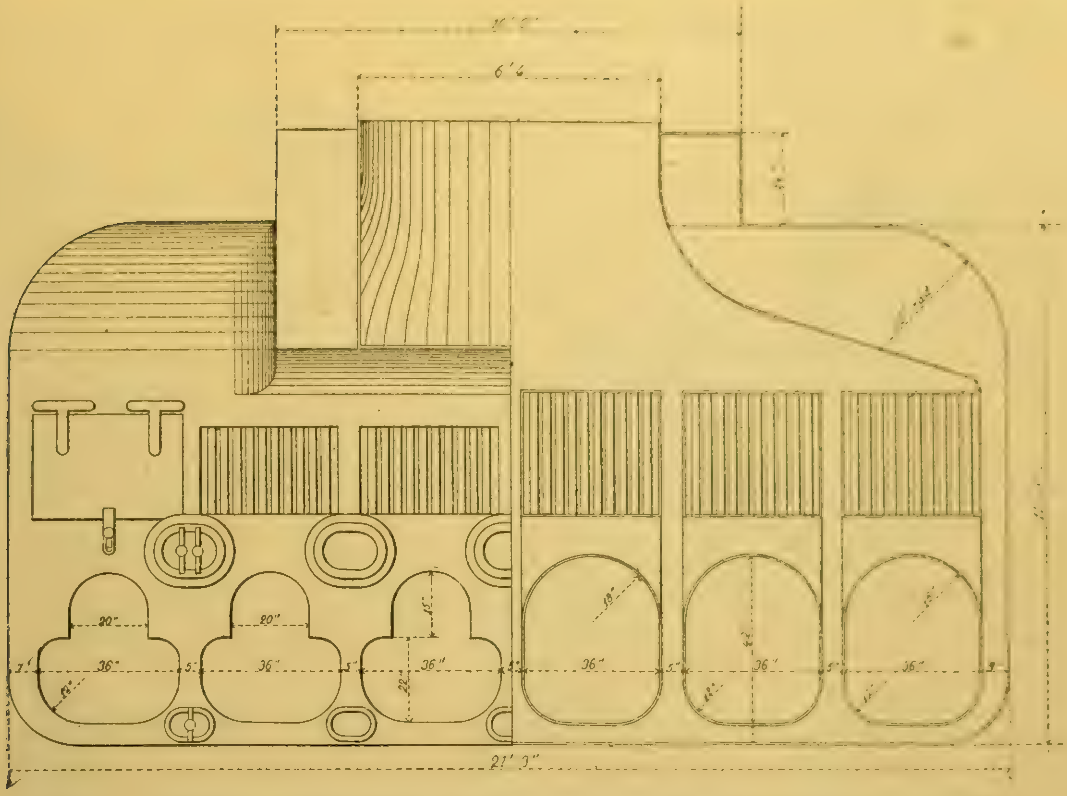


FIG. 4. VERTICAL WATER-TUBE BOILER OF U. S. STEAM FRIGATE SAN JACINTO. FRONT ELEVATION.

vertical water legs. Marine water-tube boilers have made great advances over those experimented with in 1850; the water-tube boiler at that time was identical in weight and external form with the fire-tube boiler, besides having troubles of its own which were by no means popular with steam users. They were not used to any great extent, but found their way into a few naval vessels and some in the commercial marine, from which last they found their way out again precipitately on account of inherent

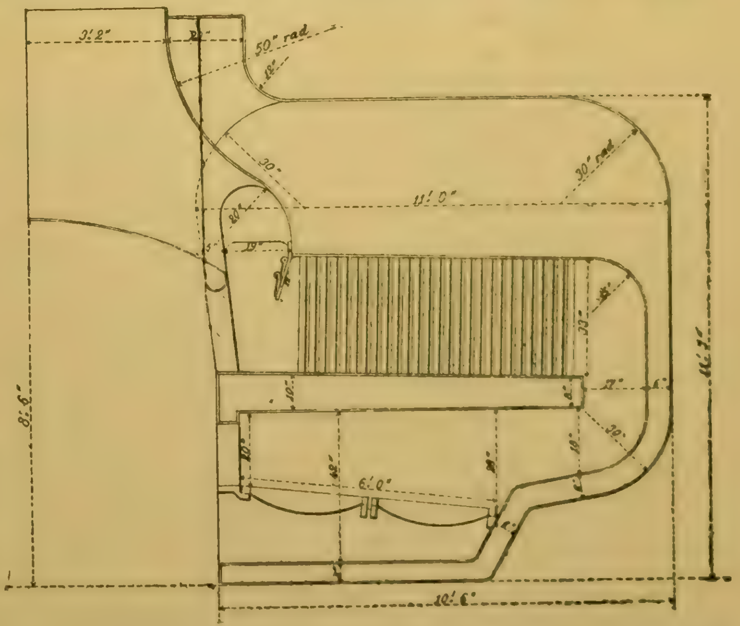


FIG. 5. VERTICAL SECTION OF SAN JACINTO'S WATER-TUBE BOILER.

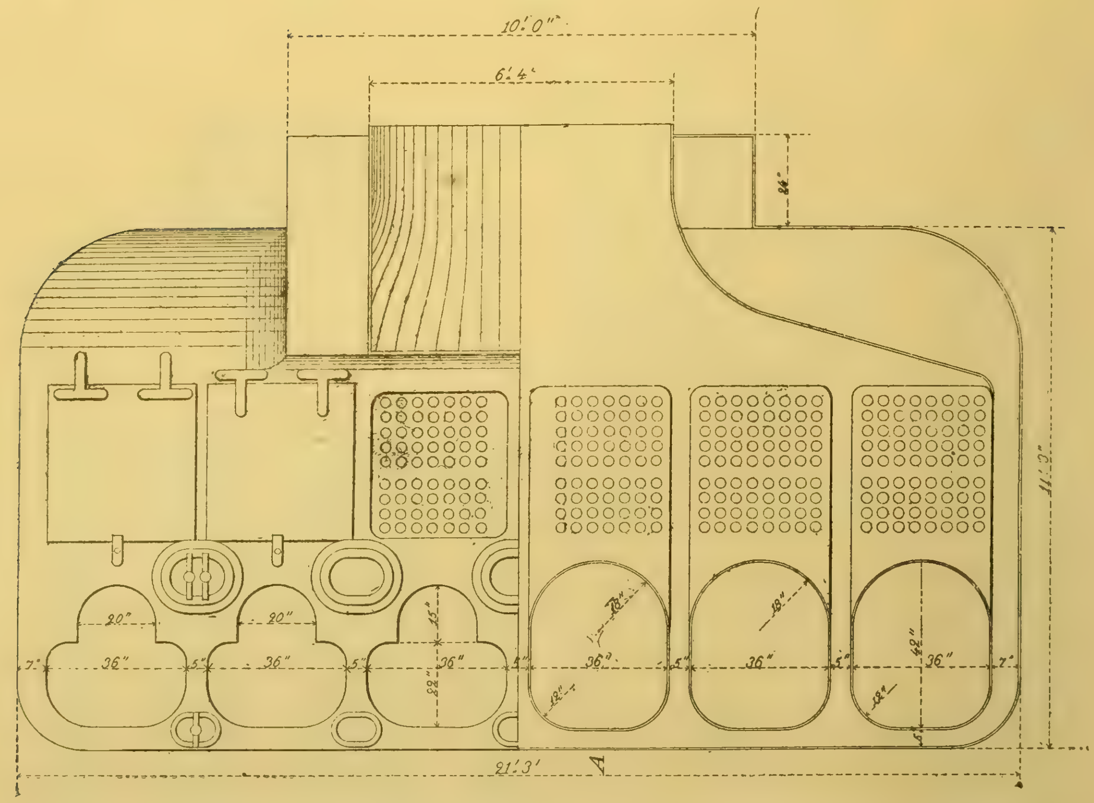


FIG. 6. HORIZONTAL FIRE-TUBE BOILER OF U. S. STEAM FRIGATE SAN JACINTO. FRONT ELEVATION.

defects which were impossible to overcome. The tubes, being vertical and only 2 inches in diameter, soon choked with salty accretions so that they were useless as heating surface, besides leaking profusely in secret places unreachable by the hand of man. These boilers were in the Fulton and Arago, of the Havre line; I have seen them come into port with five or six pounds of steam only, at a time when competition was fierce in Transatlantic trade, and heard the engineers bewail their hard fate in having to

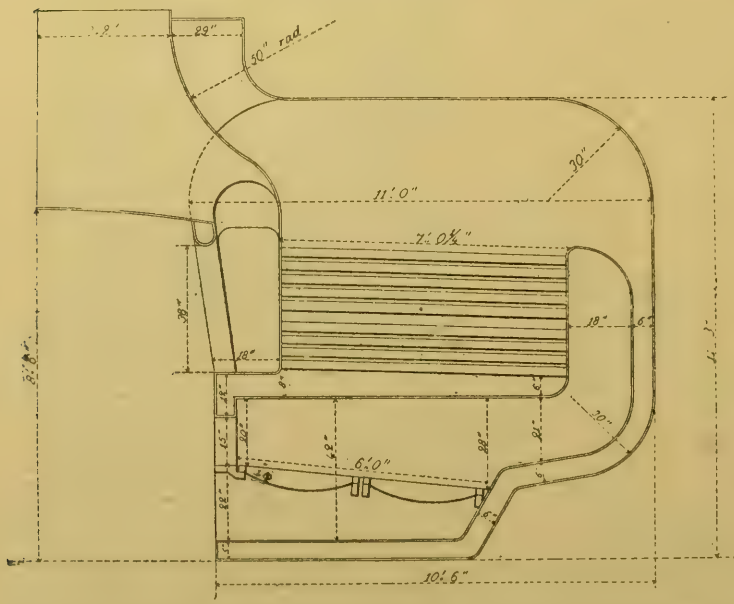


FIG. 7. VERTICAL SECTION OF SAN JACINTO'S FIRE-TUBE BOILERS.

deal with such boilers; they speedily disappeared from public use.

A very great impetus was given to the introduction of the water-tube boiler in the United States Navy by the recent war with Spain. Admiral George W. Melville, then engineer-in-chief of the Navy, said in a report and review of all the events which transpired on sea:

> "I consider the battle of Santiago to have developed the necessity of the use of water-tube boilers, whether it taught us anything else or not. It would have been of the greatest advantage to have had, during the blockade of Santiago, boilers capable of raising steam in less than half an hour. Coal need not have been used to keep all the boilers under steam all the time. The Massachusetts might have shared in the glories of the fight if she had been fitted with water-tube boilers. The Indiana could have kept up with the Oregon and the Texas. The New York would have developed at least three knots more speed, and the Navy would have been spared a controversy. I think the Colon would not have gotten away so far as she did. But we did not have water-tube boilers."

There is much more to the same purport, but this will suffice; since the Admiral's report over half a million horse power of water-tube boilers have been added to the United States navy, consisting of over five-hundred individual boilers of one type, giving entire satisfaction. The diagrams, Figures 5 and 8, represent, respectively, the water-tube boilers in use in the Navy before 1855-6 and those in use at present. There is no comparison between them either in point of efficiency, weight for power, economy of fuel, or facility in raising steam.

The engravings also show, respectively, the water-tube boiler of 1855 and of 1905. The changes, it will be seen, are very marked. The only difference between the water-tube boiler of the earlier period and the fire-tube boiler is the substitution of vertical water tubes in lieu of horizontal fire tubes; in all other respects the boilers are identical. Both have braced and stayed shells, and both occupy the same amount of cubic feet of space, nearly; the weights are practically the same, so that nothing was gained in these directions by the change of type. The evaporation was slightly better in the water-tube boiler, but to offset this it was practically inaccessible for cleaning and repair. Contrast these water-tube boilers of 1855 with those of today, and we can see the progress made in half a century. Every part of this 1905 boiler can be reached for any purpose, and any leaking tube discovered and removed without sacrificing a number of others which are sound; this last defect was very marked in the early water-tube

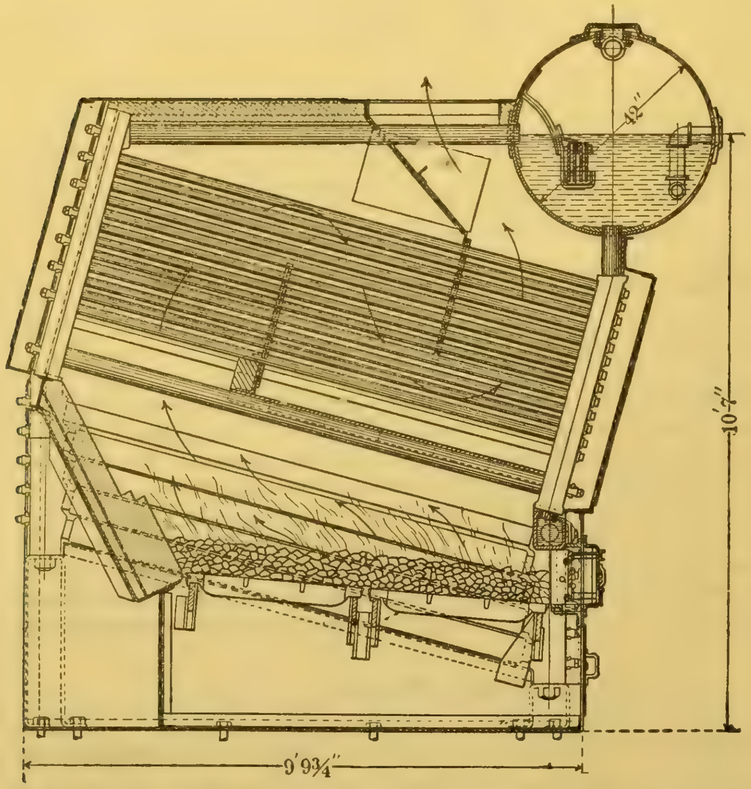


FIG. 8. A WATER-TUBE BOILER OF 1905.
The type shown is only one of many successful forms in use, but has been very largely adopted for the reason that it adapts itself well to conditions of space.

boilers. Moreover, the water-tube boiler of to-day has far greater efficiency than its antitype. It is less than half the weight, has neither braces nor stay bolts in it, and has a longer radius of action per ton of coal carried. It can be brought into action in ten minutes from no steam to a working pressure, while the old fire-tube boiler required many hours for the same duty. This is the boiler spoken of in a previous paragraph as being largely used in naval vessels, and so far it has justified the adoption of it by the Government.

In the space available for contrasting boilers of the past and the present, it is manifestly impossible to mention all variations from approved types, for these last are almost as the sands of the sea in number. Many of them had excellent features, but the inexorable fiat of daily practical use displaced them sooner or later. Those which survived for a time eventually exhibited signs of premature degeneration and signed their own warrants of dismissal from service. The boilers are emphatically the lungs of a ship; if they are congenitally weak, no chances are taken with them; they are thrown out, no matter what their first cost was.

HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker and Walter Brown.

In the present article, which is the third of a series containing a very valuable practical study of the use and effects of high-speed tool steel in one of the largest American machine shops, the details of introducing the new steels, both with regard to the men and to the machines, are discussed. The first article, which appeared in September, showed that, in general, the factory manager will find it to his advantage to replace carbon by alloy steel only gradually, under expert advice, and to adapt his existing equipment to the new conditions as far as possible, and work it to the limit until it is worn out. The second article dealt with the internal adjustment of shop conditions—both as to men and as to jobs—to the use of the new tools. The third, now presented, takes up the actual handling of the tools.—THE EDITORS.

III. MAKING THE TOOLS.

NO man of sufficient intelligence to be a factory manager or superintendent needs to be told that under suitable conditions of manufacture it is cheaper for a user to make his own tools than to buy them made to order. But such suitable conditions do not always prevail, especially in the small factory; and it happens therefore that it is often more economical, as well as more satisfactory from other considerations, to purchase tools in preference to making them.

The production of tools from high-speed steels is not really a trade in itself, but it differs markedly in certain of its aspects from the manufacture of carbon-steel tools, and requires, for the attainment of satisfactory results, appliances and knowledge not necessary to the latter. At least, this is the case in respect to any but the more simple forms of tools. These latter usually require little in the way of special appliances. The same special knowledge requisite for the more complicated forms is however necessary in the treatment of the simpler ones. The question of buying *vs.* making high-speed tools, therefore, can only be answered according to the conditions prevailing in each individual plant. In the large factory, the tool-making equipment is quite likely to be adequate to the new requirements, or may readily be made so; and the toolsmiths already employed can be brought to acquire the requisite skill in handling the new material; so that in such a factory the question does not usually arise. Even the small factory requiring a considerable number of metal-cutting tools will have a tool dresser in the shop, though very likely lacking facilities for the production of any but the simplest forms. These the toolsmith can learn to make of high-speed steel just as readily as of any other material. But he must learn—unless indeed he has been fortunate enough to have already acquired the new knowledge and skill. Thus equipped, there is no reason why the small shop should not manufacture most lathe, planer, shaper and similar tools.

When first put on the market, the alloy steels were usually sent out unannealed, just as the bars or rods came from the hammer or rolls. It was a common practice to cut or break off pieces of a suitable length, grind to the required point, and use the steel thus without heating or any other further treatment. Generally such tools did pretty good work, but frequently the results were not all that could be desired. Hence arose the complaint of unevenness in the quality of the new steels—a complaint that has almost entirely disappeared since the practical withdrawal of the unannealed stock from sale, and the consequent necessity for proper hardening before using in the machine. The makers, regardful of their own interests, prefer to send out the annealed stock because it hardens better and is less liable to fail from internal strains set up by the rolling or hammering, and will therefore give better results and in consequence increase the demand. The unannealed stock is still to be had; but there is rarely any advantage in using it. The annealed stock on the contrary has the advantage of permitting the bar to be nicked and broken off, thus avoiding the necessity of heating and cutting in the usual manner. Furthermore, the unannealed bars may be machined either with or without forging, and the tools made from them have less liability to breakage in the shanks or necks under the heavy strains imposed by the high duty required of them. This high duty, the tremendously increased stresses under which the new tools will be working, makes it important to use bars of greater cross section than formerly; for while the high-speed steel is tougher and harder than carbon steel, the strains resulting from the increased speeds and feeds are usually much greater than this additional strength will compensate for.

Next to the material itself, the most important factor in the successful use of high-speed steel for tools is the toolsmith. Unless the tools are properly made after intelligent design, little but disappointment can be expected. He must be not only a good workman, but of a receptive mind. All that he knows about carbon steel will help him little in working with the new alloys. The color scheme that served him so well in working with ordinary steels not only will not serve him when applied to the new steels, but if applied at all will lead to utter failure. He must give up most of his previously acquired notions on the subject of tools, and give himself to the acquisition of the new methods required by the new qualities and properties with which he has to deal. Fortunate the shop that starts out properly equipped in this respect.

The former practice of using stock direct from the bar, without forging or heating, is now necessarily superseded because of the almost exclusive use of annealed stock. This requires heating anyway, in order to harden it properly, and it is therefore more economical to forge the tool to about the shape required and then grind it to a cutting edge than to grind it to shape. The fire for this heating need not differ essentially from the ordinary forge fire. Any good forge will give the required heat, for small tools at any rate. The important thing is to bring the heat up gradually so that the whole mass of metal to be worked shall be uniformly hot. It is in this particular that an ordinary forge fire is not always satisfactory, particularly as regards large tools. The heat does not penetrate the interior uniformly because of the difficulty of applying it equally to all sides at once. This difficulty can be largely overcome by laying up a hood of fire brick so as to form a sort of small enclosed furnace. Such a hood helps to keep away currents of air and prevents much surface radiation. A regular and clean fire supported by plenty of fuel is essential to good work. The heating should proceed as rapidly as may be without over-heating the corners. The fire must not be too keen, or it will not heat through until after the outer portions of the piece have been hot enough for some time, and very likely damaged by the melting of the edges; neither must it be too slow, for in that case the tendency is to heat the tool farther up into the shank than is desirable.

The proper degree of heat for forging lies within a range of colors reaching from, say, a bright red to a bright yellow. No hammering should be done at a heat below the former, for the tendency will be to develop flaws and fine cracks.

For hardening a very different heat is necessary. The heating can still be done in a fire such as has been described above; but better results are obtained by the use of more or less specialized furnaces. The hollow fire is really indispensable for this purpose. However, it need not be an elaborate affair, especially for use with the simpler forms of tools. Such an one as described above, formed around an ordinary forge fire, works very well in the case of simple lathe, planer, and similar tools that require no machining. Even in such cases a makeshift of this sort is of doubtful economy except possibly where but a very few tools are to be made. A properly designed furnace will give much better results, and will therefore pay for itself in a short time, even in the small shop.

The heating is carried to a point where the steel shows a clear white color and the surface begins to flux. This will be just short of the melting point. Certain makes of high-speed steel reach a good hardening heat somewhat short of the white color; but in all cases the heat should be high enough to make the flux run. As in the forging heat, care must be taken that the heating be gradual, uniform and thorough. How far back into the shank the tool is to be heated will depend upon the stock used. Usually, if unannealed, it is better to heat only at the point, so as to leave the neck and supporting part as thoroughly annealed and tough as possible. If, however, the unannealed stock be used, it is better to heat a considerable distance back from the point, farther by quite a little than it is to be hardened, so as to leave that part as soft as may be. Some brands require, or at any rate are better for, this treatment always. The direction papers sent out by the makers will usually indicate when it is desirable.

For the more elaborate tools, those of special forms and also those requiring to be machined before hardening, good practice indicates the use of special methods of heating, or at least the use of a properly designed furnace. It is presumably well understood that all tools with projecting edges or gained surfaces, such as drills and milling cutters, are peculiarly susceptible to cracks from the internal strains set up during the hardening process—cracks that sometimes do not appear until long after the tool has been set to work. It is therefore important to take all possible precautions to prevent such strains as far as possible by the use of approved methods and appliances in preference to the simpler forge fire already described.

The form of the furnace is immaterial within certain limits. The important considerations are that it shall be economical in fuel consumption, heat uniformly and thoroughly, and be easily accessible for the insertion and removal of tools as well as for inspection.

With respect to the fuel used there is much to be said in favor of coke and anthracite coal. The oil furnace is practically out of the question because of the difficulty of heating its contents uniformly enough to meet the requirements of the class of tools now under consideration. A good gas furnace will be suitable under ordinary circumstances. It must, however, be so designed as to avoid currents of air about the heating tools. Because of the difficulty in meeting this requirement, it is generally less satisfactory than the coke furnace except when the tools to be hardened are enclosed in sealed cases as hereafter shown. A useful form of coke furnace is shown in Figure 3.

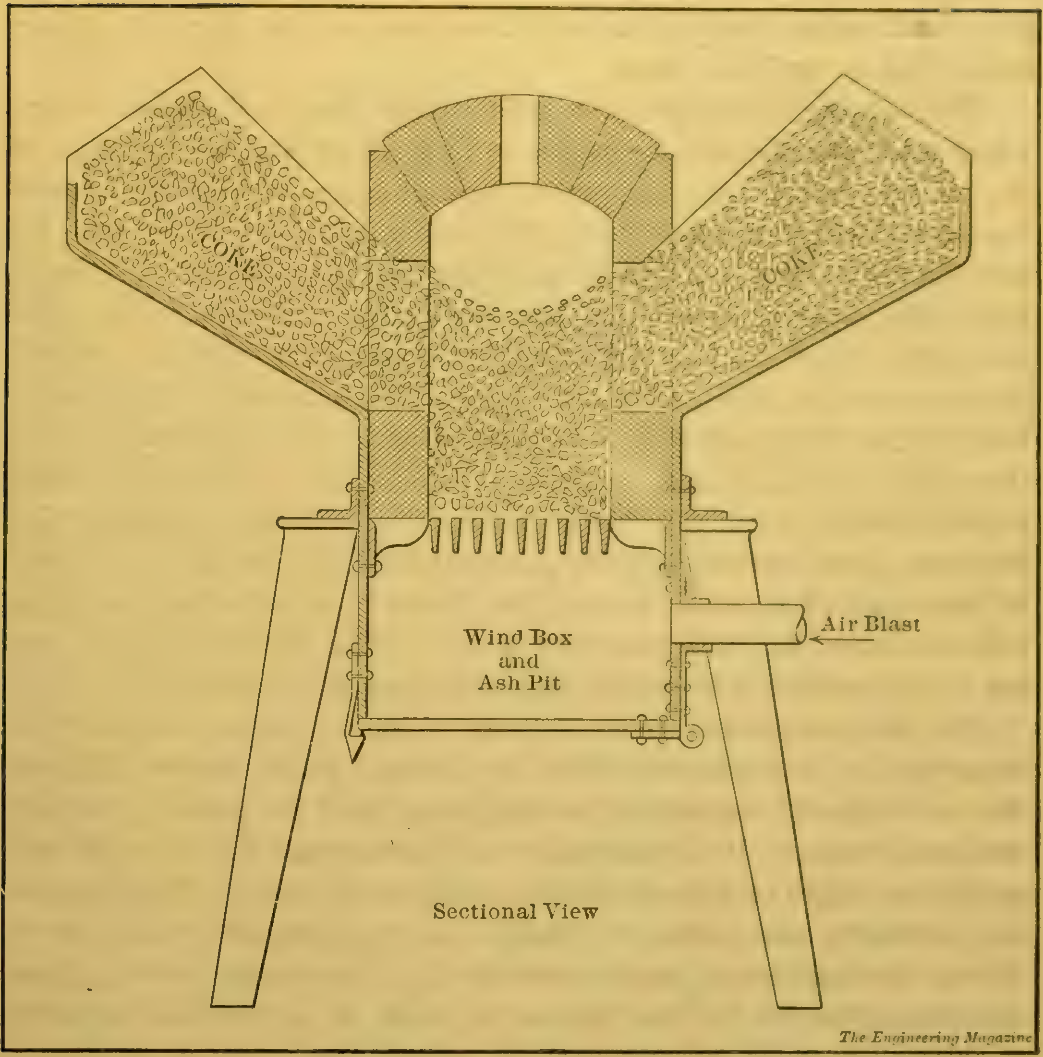


FIG. 3. COKE FURNACE FOR HEATING HIGH-SPEED-STEEL TOOLS.

Either anthracite or coke may be used. The fuel is fed from the hoppers above, passing down at each side and forming a hollowed bed of coals at the bottom. With grate bars having small (and many) openings, so arranged as to permit the ashes to be easily dumped into the completely closed ash pit, the best possible fire is obtained. If designed with some arrangement for suspending the tools so as to prevent their coming into contact with the fuel, it can be used for every kind and size of tool.

If there be no arrangement for so suspending them, or if a gas furnace be used, it will be found desirable to resort to some expedient to keep away from the fuel, and from the unburned air always found in the latter, all such tools as require accurate sizing or would be injured by possible slight distortion. A good way of doing this is to enclose them in a piece of wrought pipe, packed closely with charcoal or small coke, and sealed with fire clay. If much hardening of this

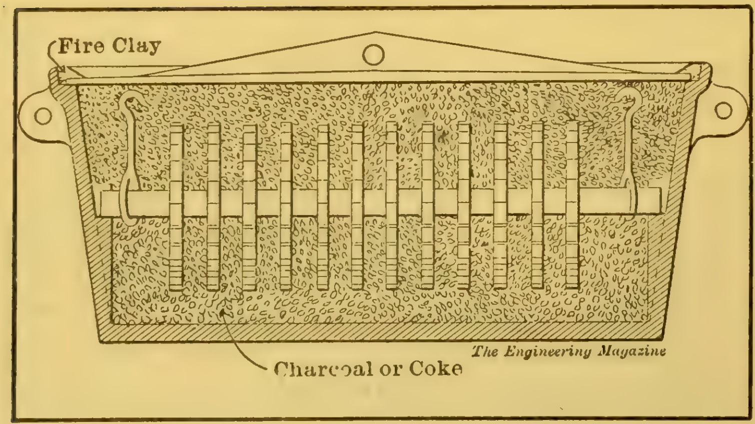


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FIG. 4. PACKING CASE FOR HARDENING TOOLS.

sort is to be done a suitable pot should be made for the purpose, something after the style shown in Figure 4. The milling cutters shown in this illustration are suspended from a rod supported at both ends, provided with hooks to facilitate rapid handling when ready to take out. The tools ought not to be in contact with each other, so that the heat can penetrate uniformly, and for the further reason that in the subsequent hardening the cooling agent also can come in free contact with all surfaces so as to avoid the internal strains likely to be set up by uneven cooling. Such a pot could be cast; but if of wrought iron there is no danger of the bottom dropping out. The pot and its contents are placed in the furnace after the latter has been raised to a white heat, and left for three or four hours, according to size. No positive rule can be laid down respecting the exact length of time for the heating. The operator must be guided by his judgment and previous experience. The old expedient of withdrawing from time to time wires inserted in the pot for that purpose is frequently useful in showing the condition of the contents. A pyrometer would of course be of advantage here; but the cost of one that is always reliable and is at the same time easily kept in repair is considerable—greater than most managers will care to assume in the early stages of their high-speed-steel experience. Such an apparatus, however, is of great value in the production of tools of uniform quality, which certainly is a desideratum in a well conducted shop. Refined methods are much derided in certain quarters; and it is conceded that such a thing as over-refinement is quite possible. A tool that is "good enough" for the work required of it is just as good as if twice as much expense had been incurred in making it. But it *must be* good enough for that work, or it becomes a very expensive tool by reason of the material it spoils. For very accurate work, therefore—that is, for tools that need to be closely sized and of uniform quality—refined methods and appliances represent money well spent.

Now a word as to the reason for casing or otherwise protecting accurately made tools. Nearly every worker with high-speed steel has noticed and doubtless remarked upon the pitted appearance frequently seen on tools after heating. The explanation of the phenomenon is very simple. The pits are caused by the scaling, that is, the oxidation of the steel in the presence of air. Under the high heats to which the steel is subjected, the oxygen of the air blast attacks the metal with great activity, and forms scales, leaving the pits beneath. A similar effect takes place when the steel is left in contact with the fuel through which air is passing, as is always the case in a coke or coal fire; or with which air is mixed, as is the case with gas and oil. In the oil furnace the blistering and pitting effect is especially noticeable. The only satisfactory way to prevent this action in such a furnace is by the use of a muffle or the packing case described.

And now we come to the hardening of the tool. For this process, as for the heating, very simple apparatus can be made to serve. In fact, some excellent results have been obtained with no apparatus at all, for most makes of the new steels harden with tolerable evenness on exposure to the air merely. Of course the degree of hardness depends somewhat upon the rapidity with which the cooling takes place, and the air should therefore be as cool as may be, and preferably in motion. Even then, however, the tool is likely to be softer than it ought to be to get good results on certain kinds of work. It is much better to use air under pressure. Air supplied from a blower does very well; but compressed air is better. It cools the tool more rapidly, and can be better directed to the exact place required. It is a very convenient hardening agent, is recommended by the makers of nearly all brands of high-speed steel, and has but two disadvantages, neither of which seriously affects its usefulness: the cost, and the oxidation of closely finished tools. As already pointed out, heated steel and the oxygen of the air combine readily, and an expensive and accurate tool may easily have its precision affected in the air blast. The cost of air is usually overlooked in shops, particularly where relatively little is used; but it is really an expense that needs to be considered. Compressed to gauge eighty pounds at the nozzle, such air costs about eighty cents an hour when flowing freely from a half-inch opening, reckoning the charge at four cents per thousand feet of free air. The evaporation from the oil bath is insignificant, and the expense of replenishing almost negligible: whence it follows that considerations of economy would indicate the use of oil. Furthermore, many makers recommend the use of oil in preference to air for all finishing tools and such others as require subsequent annealing or "drawing." Experience approves the recommendation.

No special appliances are necessary for use in connection with the simpler forms of tools, except that it is desirable to have some arrangement whereby the oil can be kept in motion and sufficiently cool. Air bubbling up through it will do this satisfactorily. Even this is unnecessary if only a few tools are to be hardened. Fish oil serves the purpose as well as any other. The chief thing is to have the bath near at hand, so that as soon as the tool reaches the required white heat it may be at once quenched. The immersion should be vertical and gradual in the case of all long tools. It is not safe to submerge the tool beyond the point to which it has been properly heated, either; for cracks or checks are quite likely to result. The immersion should continue until the tool can be handled safely. Further cooling can take place in any dry place. The tool is ground dry.

Those tools likely to be affected by oxidation, having been heated in a muffle or packing case, are removed as quickly as possible and *plunged* into the bath, remaining until cool enough to handle. Care must be taken that when dipped they are not (in case of several being suspended and hardened simultaneously) in contact with each other. It is important that there be free contact of the oil with all surfaces of each piece; otherwise there will be unequal cooling and consequent internal strains, with the inevitable cracks, as already pointed out. Of course such tools could be packed for heating without suspension, and hardened separately; but if this be done there is no assurance of uniformity in the hardening. The last pieces dipped will certainly be somewhat cooler than the first, and will furthermore have been exposed to the oxidizing influence of the air while waiting their turn.

For such shops as make many tools, a properly designed oil bath is a necessity. Figure 5 illustrates the essential features of a satisfactory arrangement—namely, an oil tank of suitable size suspended in a larger tank filled with water. The cooling tank is provided with suitable intake and overflow for circulating the water. The oil is kept in circulation by air bubbling up from below.

A peculiarity of the alloy steels is that the fitness of a tool for its particular work does not necessarily depend upon its degree of hardness. Indeed, some of the best results have in certain instances been obtained from tools soft enough to take a file. It must not, however, be inferred that softness is usually a desirable quality in such tools. As a matter of fact, under ordinary circumstances any considerable degree of softness results in the tool quickly "gumming," particularly in the case of reamers, drills, and other tools subject to a great deal of friction while working, with the result that the tool is soon spoiled. Only experience will determine just what is best. It is, however, a safe rule to make all tools as hard as the shape and use will admit. It

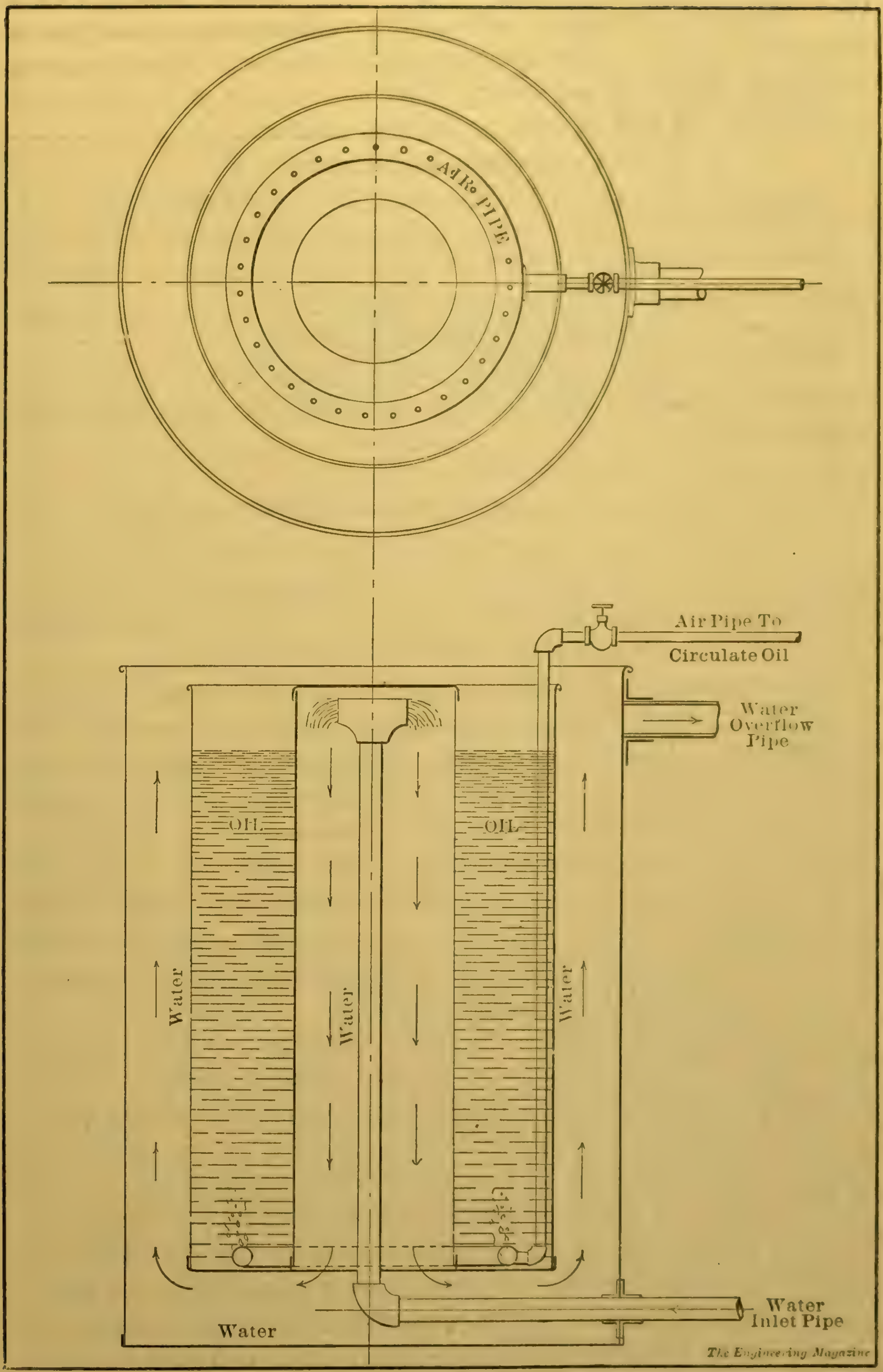

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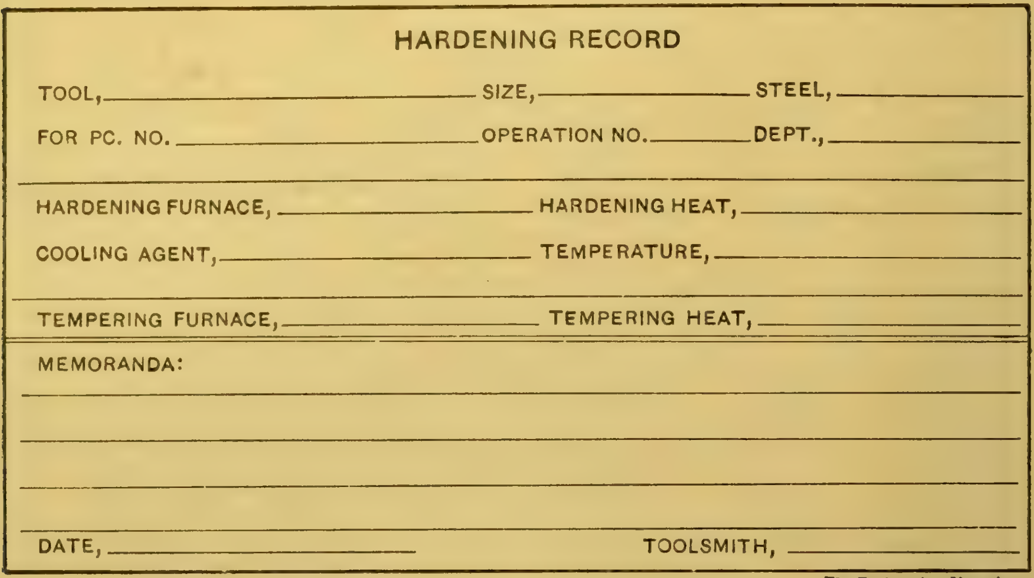
FIG. 5. OIL BATH WITH WATER COOLING DEVICE.

is obvious that thread-cutting dies, taps, and most cylindrical or circular cutters with small cutting edges, must be soft enough so that these edges will not crumble. Since the hardening process permits but little amplitude in respect to degree, it is necessary to resort to the old expedient of "drawing."



HARDENING RECORD

TOOL, ______ SIZE, ______ STEEL, ______

FOR PC. NO. ______ OPERATION NO. ______ DEPT., ______

HARDENING FURNACE, ______ HARDENING HEAT, ______

COOLING AGENT, ______ TEMPERATURE, ______

TEMPERING FURNACE, ______ TEMPERING HEAT, ______

MEMORANDA:

DATE, ______ TOOLSMITH, ______

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FIG. 6. FORM FOR RECORDING HARDENING DATA.

Up to this point in the making of the tools no good toolsmith need have gone far astray. Unless uncommonly cautious, however, or provided with accurate heat-measuring apparatus and reliable reference tables, he is very likely to experience much trouble, and in the beginning to make many failures, in tempering the new steels. His experience with carbon steel will not avail him in the tempering of high-speed tools. Indeed, unless unusually careful he is likely to be constantly misled by that experience, because the colors indicating proper heats for the latter are quite different from those he has been used to. As a matter of fact, color is not a safe guide anyway, in treating the new steels. There are so many possible variations in temper within a range of color scarcely distinguishable to the eye, that if anything like uniformity is desired it is necessary to use temperature gauges and to preserve records of experience. In the absence of any special conditions or requirements it will usually be safe to draw formed cutters, taps, threading dies, drills, reamers, milling cutters, and similar tools to a dark straw color, which represents about 260 degrees Centigrade. A study of the performances of various tools as shown by the records described in a former paper, in connection with suitable memoranda relative to the treatment of the particular tools, will lead to the determination of suitable standards for the various kinds of work. It

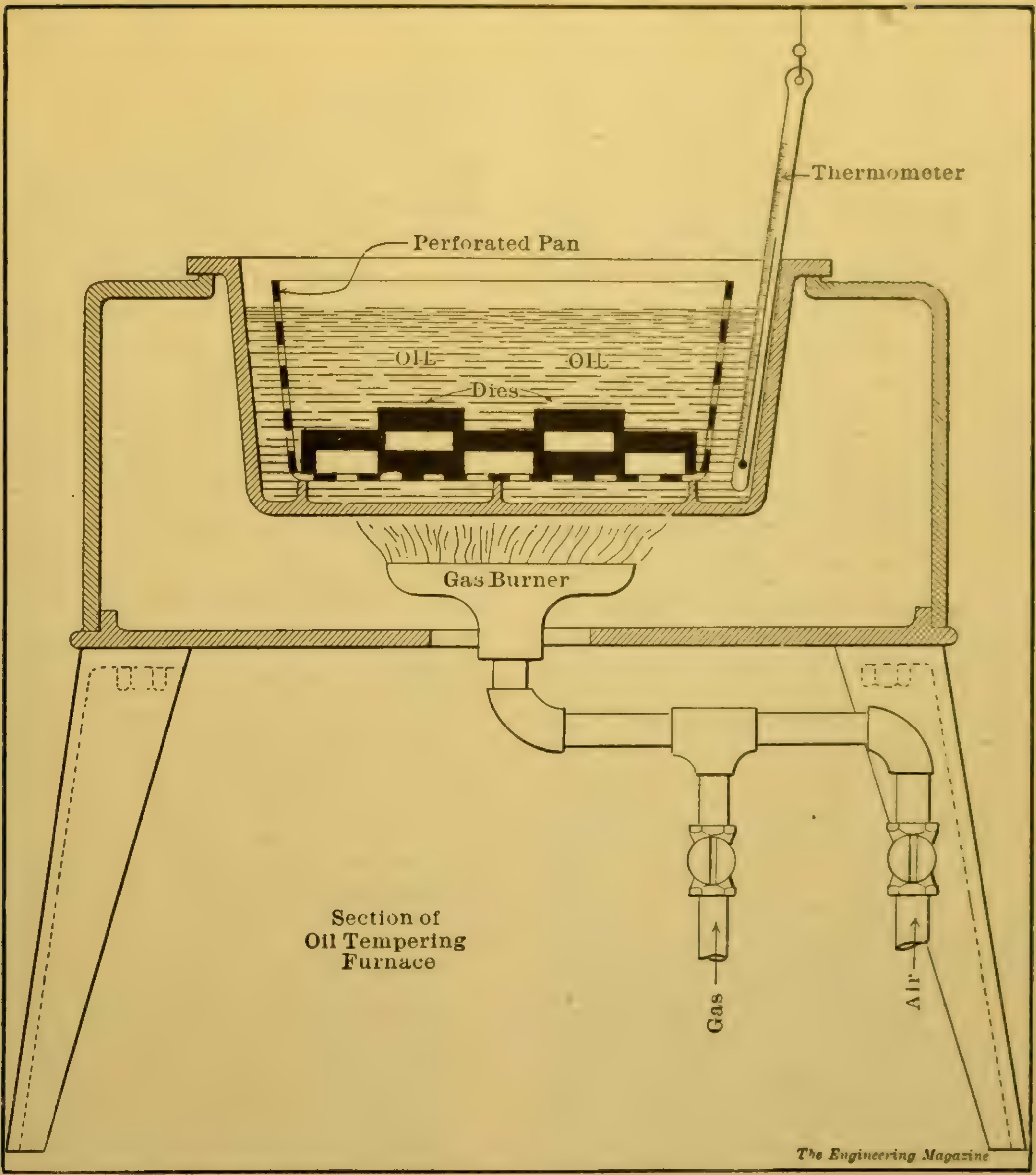

FIG. 7. SECTION OF OIL-TEMPERING FURNACE.

will be found that the tools requiring the greatest toughness, like taps for instance, will need to be drawn much farther than usual, sometimes as far as 350 degrees C., or until the steel shows a slight greenish tinge. A suitable tool-tempering record is shown in Figure 6.

The most exact methods are none too good for making the best tools. The furnace described above may be made to meet the most exacting requirements, if provided with all the necessary arrangements for regulating and measuring temperatures. A simpler and less expensive arrangement, furthermore one that is found by experience to be much more convenient and less likely to need costly repairs, is the oil tempering furnace. A good type of such an apparatus is illustrated in Figure 7, which is perhaps sufficiently self-explanatory.

EDITORIAL COMMENT

MR. WALLACE'S article, which appears in the leading position in this issue of THE ENGINEERING MAGAZINE, will be immediately recognized as having a most important meaning in the present state of the Canal question. It is, perhaps, the most significant of all the striking contributions to the subject which we have had the honor to publish during the past nine years—not only because Mr. Wallace has had larger opportunities than any other living engineer to measure the undertaking as a work to be done by the United States, but because what he reveals throws a new and long-awaited light on the real possibilities and the very real dangers of the situation.

Mr. Wallace's direct and straightforward statement covers three main points :—

First, he summarizes briefly what was actually done during his year of residence on the Isthmus—the first year of actual work by our Government. He states the total result accomplished, and the general unit costs determined. This condensed record of progress, coupled with what Mr. Wallace has previously written for our pages, will give the friends of the enterprise, whether in or out of the engineering profession, a broad idea of the present status, as well as a basis for further study and comparison.

Second, he offers a brief synopsis of his conception and plan in attacking the construction work, and of analyzing the records of this experimental period so as to enable a sound decision to be made upon the choice of the type of canal and the methods of building it. This demonstration of the common-sense of civil-engineering methods will certainly carry home a lively conviction of the way in which the work should be approached—and, we hope and believe, a controlling determination to insist on the maintenance of the best engineering standards in the completion of constructive work on the canal.

Third, and most immediately important, he points—with restraint, but yet so clearly that no reader can be mistaken in the meaning—to the disastrous influences of "governmental red-tape," which have stood squarely in the way of carrying out this practical and necessary policy. In so doing, Mr. Wallace evidently indicates, briefly and temperately, certain reasons which compelled his retirement from a position which he could not continue to fill without danger, as it appeared to him, to his reputation, nor without compromise of his ideals.

> "It should be plainly evident that Governmental methods which require from ten to twelve years to complete a structure such as the Federal building in Chicago—which, under private individual ownership and control could have been erected in the space of a single year, at most two—cannot be applied to the construction of the Panama Canal with satisfactory results, if the present generation is to derive benefit from its accomplishment, and at reasonable cost."
>
> *John F. Wallace.*

It is profoundly to be regretted that into the negotiations looking to a retirement which was unquestionably Mr. Wallace's professional privilege, and which might have been accomplished without any prejudice to the Canal enterprise, there should have entered elements forcing a situation full of peril not only to personal and professional reputations, but to a National undertaking.

But this unfortunate event is not to be permitted to deprive the country of the invaluable fund of knowledge of the Isthmus, especially of the Canal work, which Mr. Wallace possesses, and which would be lost to the country without his report. It appears that the lack of opportunity to draw freely upon this fund has already cost the Advisory Board valuable time and effort. At best, they can have received only fragmentary studies, representing no doubt careful and painstaking work, rich in valuable detail, but after all only the partial contributions of assistants, none of whom saw the complete plan of study nor the exact relations which his work bore to the entire plan. The Administration, the Advisory Board, and the country, will receive the full benefit of the past year's work only by receiving Mr. Wallace's own report, and its interpretation.

At the moment of going to press, we learn that this happy result is secured.

* * *

It is generally admitted that extended practical experience is necessary in order that any mechanical device may be perfected, and engineers of all men realize the great value of working tests and trials of operative machinery. Such tests, however, should be conducted upon both scientific and practical lines, one of the important results sought being the elimination of what may be called "freak" constructions and ideas.

In the course of the development of the automobile it has unfortunately been assumed that valuable information would be acquired as a result of elaborate speed-trials and races, and this view has not been discouraged by those interested in the production of sporting vehicles and the conduct of road racing. As a matter of fact, the racing automobile is necessarily a freak, designed to meet the sole requirement of maintaining a maximum speed for a limited period of time, and the race once over the winning machine becomes as uninteresting as an exploded fire-cracker on the fifth of July.

In this respect there is not much difference between automobile racing and the various yacht races which are held from time to time in connection with that ungainly piece of silverware known as the Queen's Cup. There are few, even among the most enthusiastic yachtsmen, we believe, who would venture to affirm that the international yacht races contribute any information of value in connection with the design even of pleasure yachts, while the intrinsic worthlessness of the cup challengers and defenders themselves is clearly shown by the insignificant prices which they subsequently bring when offered for sale.

It is worthy of note that at a time when automobile racing is being encouraged in the United States it is already being superseded in France by the far more intelligent work of the Automobile Club in the conduct of extended road trials of industrial and military vehicles. We have given elsewhere in this issue a review of these important and valuable investigations, which should appeal both to the engineer and the manufacturer in a way which no speed trials can possibly do.

It does not require a succession of wild rides over country roads to demonstrate to intelligent people that higher powering will enable higher speeds to be made, but it is necessary to put industrial automobiles through exhaustive and continuous tests to determine the elements required for endurance, economy in cost and operation, and efficiency in daily service. The army engineer demands a machine which can be operated in a rough and arid country, which can pull itself out of holes, and which will not get stuck in the mud. The truckman requires a vehicle in which the paying load shall be a maximum, and the wear and tear a minimum, while in all cases the industrial automobile must show itself the superior of the horse or even of the despised army mule, before it can be held to have met the commercial demand.

The manner in which this question of reliability trials is regarded in France is shown by the remarks of the Marquis de Dion, after the conclusion of the recent tests of industrial vehicles. Referring to the influence of this year's trials the veteran automobilist says:

"By next year we shall undoubtedly see the results of this idea, and we shall organize a much greater series of trials for endurance and reliability, over a course of 5,000 kilometres in length, the daily runs being from 300 to 400 kilometres. All the parts of the vehicles will be registered, and no repairs will be allowed except those which can be made by use of the appliances carried on the vehicles themselves. An average speed of 35 to 40 kilometres will be required, according to the various classifications, and these requirements will be checked by secret supervision and timing. In this way we shall prevent the vehicle which is really reliable and trustworthy from being beaten by some dangerous monster which is broken down for a part of the time, and then driven at a speed of 100 kilometres to make up lost time.

"In this way a preparation may be made toward the true evolution of the automobile, diverting it from the high-speed racing tests now so much in vogue, toward a more useful and valuable service."

When such opinions as these are being expressed in France, the country of the development of the racing machine, we may well hesitate before encouraging road racing in the United States. There is no reason why the practical abilities of the American engineer should not be turned directly to the proper field for automobile experiment, without foolishly repeating what has already had its day on the Continent.

An article in *Engineering News* last June called attention to the fact that some 40,000 engineers are already practicing in the United States, and at least 15,000 students were then preparing to enter the profession. Doubtless since the schools of the country assembled for the winter courses, this number is considerably increased. The *News* drew, as the main conclusion, the deduction that the majority of young men now studying for the engineering field "must eventually find positions requiring fully as much knowledge of business as of engineering, and that our engineering colleges should recognize this by giving their students better training in business methods."

This is substantially the proposition which we have more than once advanced, in urging specifically upon the notice of our larger technical schools the claims of "production engineering" as a recognized and individualized course. We should be inclined to transpose the recommendation as phrased by the *News*, and define the modified course not as "business methods applied to engineering," but as "engineering training specialized to the management of manufacturing or productive industries." But whatever the terms used to express the idea, there can be no question that the time is ripe for one or more of our larger technical colleges to give it substance. There is an increasing demand for the close scientific management of large engineering works and manufacturing plants, and the training which will fit the student for entry into that field should be as distinctly differentiated as that which prepares him for stationary steam practice, marine engineering, or electrical work. The situation is not unlike that which existed when electrical engineering was first made a distinct subject. The wonder is that the schools are so slow to recognize it.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

EFFECTS OF HIGH TEMPERATURES ON STEELS.

INVESTIGATIONS ON THE INFLUENCE OF HEAT UPON THE ELASTIC PROPERTIES OF STEEL.

B. Hopkinson and F. Rogers—Royal Society.

As an interesting indication of the manner in which the methods of the physical laboratory are being applied to the solution of engineering problems, the work which is being done by Messrs. Hopkinson and Rogers in investigating the elastic properties of steel at high temperatures may be noted. In a recent communication to the Royal Society there is given an account of the researches which are being conducted in this direction, and although the work is by no means completed it is of immediate interest and value in its present form.

"Hitherto investigations into the elastic properties of metals have been confined to comparatively low temperatures. Gray, Dunlop, and Blyth have measured the modulus of rigidity and Young's modulus for wires up to temperatures of 100 degrees C., and found that both these quantities decrease as the temperature rises. Martens determined the influence of heat on the strength of iron up to temperatures of 600 degrees C., but his experiments were the ordinary tensile tests carried to rupture; and though he also found a substantial diminution of Young's modulus with rise of temperature, he did not go into the point fully, being mainly concerned with breaking stress and elongation.

"In the experiments here described the elastic properties of steel and iron have been investigated at higher temperatures, ranging up to 800 degrees C., and for stresses greatly below that required to rupture the material. It is found that as the temperature rises the stress-strain relations undergo a remarkable change, which may best be expressed by saying that what is variously called the time-effect or *elastische nachwirkung,* or creeping, increases greatly with the temperature. Steel at high temperatures behaves like india-rubber or glass; if it is stressed for a time, and the stress removed, it does not at once recover; but after the immediate elastic recovery there is a slow contraction perceptible for many minutes. Such creeping can be detected at ordinary temperatures, but at a red heat it attains a different order of magnitude, becoming (in its total amount) a substantial fraction of the whole deformation."

The experiments of Messrs. Hopkinson and Rogers were conducted with the aid of an electric resistance furnace, the test specimen being placed in a vertical position in the middle of a resistance composed of three coils of nickel wire, this enabling satisfactory control of temperature to be maintained. The apparatus permitted the rapid application of loads up to 1½ tons per square inch to be made, while an extensometer of Professor Ewing's pattern enabled changes in length to be measured up to the 50,000 part of an inch. The interior of the furnace was closed from the atmosphere by means of mercury seals, and the test piece was surrounded by an atmosphere of nitrogen, in order to prevent oxidation.

The trials, so far as made public, have been made upon two kinds of material, one being steel containing about 0.5 per cent. of carbon, and the other being Low Moor iron. The results are shown in diagrams accompanying the original paper, from which some interesting deductions may be made.

The maximum temperature of the trials was 750 degrees C., the bar being loaded up to about 1¼ tons per square inch for one minute and then unloaded for two minutes, this sequence being repeated a number of times, giving a curve showing the resulting changes in length in terms of time. Even at this low stress the metal is shown to flow fairly rapidly, and the overstraining has a considerable hardening effect, this appearing in the diminishing amount of permanent set reproduced by the successive loadings. The hardening thus produced disappeared with rest, so that if the test bar is permitted to remain unstressed at a temperature of 750 degrees C. for a few hours after having been hardened by successive loadings, it is found to be restored to its original soft state. This flow of the metal is very much slower with a slightly lower load.

"In respect of all the features hitherto mentioned the properties of the material differ only quantitatively from those of the cold bar. The results might, but for one remarkable difference, apply to a cold bar stressed to its yield-point. The difference lies in the behavior of the bar after the removal of the load. The cold bar does not contract appreciably; there is the instantaneous elastic contraction, then it stops. The hot bar, on the other hand, goes on shortening for two minutes or more after the load is off, as shown by the dotted line on the diagram, and the total amount of such shortening amounts to roughly one-third of the instantaneous contraction, or one-quarter of the total contraction, or one-fifth of the average total extension after hardening has taken effect.

"The iron bar behaved in much the same way, but the metal flowed at a lower stress. There was considerable flow with a stress of but half a ton per square inch. The shortening after removal of load was also perceptible at that stress.

"At 600 degrees C. both bars exhibited greater tenacity. A load of 1.6 tons per square inch applied to the steel bar for one minute produced an immediate extension of 3.8 extensometer divisions, followed by a slow drawing out which amounted in one minute to about 0.9 division. On removal of load there was an immediate shortening of 3.8 divisions, followed by a slow contraction amounting in two minutes to 0.7 division. The permanent extension produced was very small, if, indeed, there was any at all. The iron bar behaved in a similar way, but, as at 750 degrees C., it yielded appreciably at a stress which was not sufficient to permanently deform the steel bar.

"The experiment on the steel bar at 600 degrees shows pretty conclusively that this slow recovery after release from stress is not solely, or even mainly, dependent on overstrain. It seems to exist to a large amount with stresses which leave practically no permanent effect; the strain develops slowly under application of stress and disappears slowly after it is removed.

"This phenomenon is, of course, analogous to residual charge in glass and other dielectrics; the stress corresponding to the electric force, and the strain to the electric displacement. Whether the law of linear superposition of the effects of stresses—closely followed in the electrical analogy—is true for hot steel or iron, is an interesting question which the apparatus was hardly sufficiently delicate to answer.

"The magnitude of this effect in steel may best be gauged by comparing it with other cases of the same kind—*e. g.*, with the slow recovery of a glass fibre after twisting; if such a fibre be twisted through a considerable angle for several hours, it will recover all but one-fiftieth of the twist within two or three seconds of the removal of the stress. The remaining slow creep, amounting to one-fiftieth of the whole deformation, corresponds to the slow return of the steel. In india-rubber, under certain circumstances, 10 per cent. of the strain disappears in time after the removal of the stress. But in steel at 600 degrees C. the proportion is about 15 per cent.

"Another effect of 'creeping,' is to make the determination of Young's modulus a matter of some uncertainty. Thus the extension of the bar at 600 degrees C., produced by a given load varies 15 per cent. or more, according to the time of application of the load. When, however, the load is applied for a very short time—say of the order of one or two seconds—the strain produced seems to approach to a definite limiting value, which is the instantaneous extension or contraction of the bar observed in our experiments when the load is applied or removed. It seems reasonable to define Young's modulus for a metal in this state as the stress divided by this limiting instantaneous strain. It is then independent of the manner of loading, and is a definite physical constant; otherwise not. Owing to the effect of the ends, the reciprocal of the extension is not quite proportional to Young's modulus, their ratio being somewhat greater at high temperatures than at low, as already explained. With regard to this question it should be noted that the error in the determinations on the cold bar, and at 400 degrees C., is probably not more than about 2 per cent. At higher temperatures the error is greater, as, owing to the rapid drawing out of the bar, it was difficult to be sure of the instantaneous extension. It is, however, fairly certain that the ratio of Young's modulus in the cold bar and at 750 degrees C. is not more than 10 per cent. in error.

RAILWAY SHOP ORGANIZATION.

PRACTICAL EXPERIENCE IN THE ORGANIZATION AND ADMINISTRATION OF RAILWAY SHOP FORCES.

H. T. Bentley—Western Railway Club.

IT is beginning to be realized in railway shops as well as in other engineering establishments that an effective organization is an essential feature in economical administration. Private establishments are generally in advance of incorporated companies, just as the latter are undoubtedly ahead of works under government control, but in the long run it will undoubtedly be found that a united and harmonious action of all the elements of a manufacturing establishment make for efficiency, whether the concern be run by an individual, by a company, or by a government.

In a paper recently presented before the Western Railway Club by Mr. H. T. Bentley, this question of shop organization is discussed with especial reference to the requirements of the railway shop, and an abstract of the paper will be found of value and interest.

"In getting together a force of men sufficient to man a shop capable of turning out say 20 to 50 locomotives a month (it really doesn't matter how many engines the shop turns out, the building up of an efficient force is very necessary in all cases), the first consideration is to pick a man for the head, whether as general foreman, master mechanic or shop superintendent, who can be implicitly relied on to carry out the plans you formulate for him, and to have such ideas of his own that he will immediately see where delay or friction occurs and apply a remedy. As head of the shop he must have a firm disposition, be prepared to meet emergencies, have the good will of the foremen and men under him, and be tactful so as to be able to straighten out the many little difficulties that are continually arising; it is far better if he has no relatives or friends working for him as it will save lots of trouble from fancied discrimination, etc. He must be an organizer in the true sense of the word and every move he makes must be in the direction of increasing his output and decreasing the cost. He should not allow work to be done carelessly or improperly; it takes a long time to build up a reputation for thoroughness which can be shattered in a few weeks if work is slighted."

The work of a railway shop consists largely of repairs, and in such cases the question of time is generally most important, and it is in the saving of time that effective organization makes itself felt.

"When an engine comes into the shop for repairs, it should be the duty of one or more men to inspect it, and immediately order all of the new material required, and see that it is placed at the machines or benches ready to be worked on when its time comes—don't wait two or three days after the engine arrives, and then find you want something that isn't in stock but ought to be; it will probably mean a delay to engine going out, which might have been prevented if an earlier inspection had been made.

"In dissembling engines each part should be plainly marked so that when wanted again there will be no difficulty in finding it. The storage of parts that need no repairs is a matter worthy of attention. Much material is lost through neglect in storing it away where it cannot readily be found when wanted.

"To get engines or work out of a shop, there should be a classification of repairs, and each piece of work done, or each engine passing through the shops, should have a schedule of time, so that all concerned know when it will be necessary for the various parts to be ready. Don't do things haphazard. Set a time limit and work to it, making such improvement in tools, ways and means of doing work, etc., so that all lost motion is taken up and the results you are after, obtained.

"The head of the shop should have good men under him as foremen, all of them knowing their business thoroughly and at the same time being able to handle men with consideration, firmness and fair dealing; these combinations are frequently hard to get, but with a large force of men to pick from, the right kind of men can be found, who, by a little training, will meet the above requirements and soon get into his way of doing business."

An important element in the effective conduct of work is the knowledge by all of the results which it is desired to accomplish. Each man has his own definite task set before him, but it will help matters very materially to have the foremen know in a general way what is to be accomplished, and in turn they may be able to keep the superintendent in touch with details of which he might otherwise have only a general idea.

"The organization of shop forces does not end with the getting together of good foremen and men; it is also necessary to have such a systematic arrangement of accounts and reports that you will not only see that the men are getting the work out promptly, but can tell at a glance how much is being done and what it is costing. Without this knowledge you are not able to perfect the organization to its fullest extent. It also enables you to say when asking for new tools, what can be saved in time and money by their introduction, and to know whether it will be cheaper and better to purchase supplies, taps, reamers, etc., or make them in the shops.

"The superintendent of motive power who visits his shop frequently and knows all his foremen, can get better results and have the men feel more kindly disposed towards him than the one who does all his visiting by long distance telephone. A word of encouragement and a suggestion will often bring out latent ideas that otherwise might have lain dormant. It is natural for most men to like their superiors in position to come in personal contact with them and see what they are doing and whether advantageously or not, hence, the advisability of the superintendent of motive power or his assistant making frequent visits to the most important shops and keeping in close touch with the shop superintendents and foremen."

Among the important things in connection with the effective administration of a shop is the general foresight necessary to be prepared for emergency work, this involving a watch over the stock of material and reserve power which may be needed, and for the lack of which serious delays may be caused.

"The motive power department organization can be demoralized and nearly put out of business if it is not backed up by the storekeeper and accounting departments. The prompt furnishing of material in sufficient quantities to keep machines going long enough to perform the work economically is a matter that must have attention, otherwise the cost will immediately go up. The setting up of some machines often takes longer than to do the work, if furnished in small amounts, and a direct loss to the company takes place. The furnishing of cost sheets within reasonable time after the work is done is very helpful in detecting increased or decreased cost and applying the remedy in the former case before the matter gets old. In some shops messengers are used to deliver material and they are great time savers when used in connection with a shop telephone system. The ordering of material is done by 'phone to storehouse and deliveries are made from there by boys or men, thus obviating the necessity of high priced mechanics going back and forth doing work that is just as well performed by cheaper labor."

In general the elements of good shop organization may be summed as including a good man at the head of the works, good men under him, a continual education of foremen and men, and proper control of men by foremen. With these should exist the essential elements of punctuality, orderliness, system, and harmony, together with prompt movement of material to and from the various departments, a good system of handling tools, and an effective use of templets and jigs wherever possible. So far as labor troubles are concerned, these may nearly always be avoided by an absolutely fair and considerate treatment of foremen and men.

SUBMARINE SIGNALLING.

PRACTICAL EXPERIENCE WITH THE MICROPHONE IN THE TRANSMISSION OF SIGNALS UNDER WATER.

The Engineer.

COMMUNICATION at sea by means of signals of various kinds has long been the subject of scientific study, and the importance of the question naturally causes all departments of applied science to be drawn upon to aid in its solution. Visual signals are employed wherever possible, both by day or by night, while the fog horn and the siren represent the efforts which, until recently, covered the application of audible signal systems. A number of years ago it was suggested that the thermo-pile might be employed to indicate, by the rise in temperature, the approach of a vessel, but so far as we are aware no practical application has ever been made of the suggestion. Recently the microphone has been used with much success to enable signals to be heard through bodies of water, and the practical development of this method has been such that it has been made the subject of experiments by the Corporation of Trinity House to determine its applicability for use in the British service. The whole subject, including the recent investigations of Trinity House, is discussed in a paper in a recent issue of the *Engineer,* from which we make some abstracts.

"The idea of passing sound signals through water is by no means new, and the advantages attending the transmission of sound by this method have long been known.

"As early as 1821 M. Colladon conducted experiments on the Lake of Geneva to test the suitability of water as a medium for transmission. He found that subaqueous sounds were totally reflected at the surface at such angles as rendered it impossible to hear them above water except for very short distances. By means of an instrument designed for listening below the surface, M. Colladon claimed to be successful in conveying distinctly audible sounds through water for a distance of 21¾ miles.

"It is well known that the rate of propagation of sound waves in water is over four times as great as the rate in air, and that an aqueous medium does not present the serious difficulties of interferences, shadows, and strata of varying density met with in atmospheric signalling. It sometimes happens that the most powerful atmospheric fog signals are inaudible to the mariner at distances of only a few hundred yards from the shore."

Researches upon the applicability of improved methods of submarine signalling have been conducted in Europe and in America for a number of years, and prominent among the investigators may be named Professor Blake, of Kansas City, Mr. A. J. Mundy, of Boston, the late Professor Elisha Gray, and others. To Professor Blake is due the valuable idea of using the hull of the vessel itself as the main receiving instrument for the sound signal, and this suggestion has been a fertile one. By placing a microphone within a tank containing liquid and attached to the ship's plating on its inner face, a receiver is obtained, which, with certain modifications, has proved very successful.

"The chief difficulty experienced in devising an apparatus for transmitting and receiving the signals on board ship lay in the presence of local sounds, of more or less magnitude, in the ship itself. Experiments carried out on the steamers running between New York and Boston in conjunction with four of the light-vessels situated between these ports, proved that, if the tanks containing the microphones were filled with a liquid having a greater density than water and placed in suitable positions against the hull of the vessel, and the transmitters regulated to the recognition of vibrations of high frequency and not those of low pitch, external sounds, such as bell signals and the noises from screws of passing steamers transmitted subaqueously, were distinctly audible, while internal noises were practically eliminated, the latter becoming dissipated in the form of hull vibrations and failing to penetrate the insulating medium in the tanks. On the other hand, with transmitters attached direct to the ship's skin, the local vibrations completely swamped those due to external sounds."

The general construction of the apparatus is as follows: The microphone is placed in a water-tight case enclosed in a small cast-iron tank, bolted to the inside of the hull, the skin of the vessel forming the outer side of the tank. The microphone is adjusted to receive notes of short wave length only, this eliminating to a great extent the disturbing noises of lower pitches, while the high vibrations of the transmitting bell are readily received. The tank is filled with a super-saturated solution of brine, except in instances where temperatures below freezing are anticipated, in which case a special solution of high density and low freezing point is employed. Such a receiver is fitted below the water line on each side of the ship near the bow, each receiver being connected to a telephone on the indicator board in the chart room.

The transmitter is a small bell, of special design, tuned to emit a high pitch note, the clapper being operated by compressed air through a piston and connecting rod. The entire mechanism is enclosed in a chamber of phosphor bronze, with the bell attached below, so that the whole can readily be lowered over the side and submerged to a point well beneath the level of the keel of the light ship or other vessel sending the signals. The intervals of the signals may be controlled or regulated as may be desired, to enable the source to be identified, and a spare bell can be lowered in a few minutes if necessary.

"Continuous trials, extending over ten days, have been made with a submerged lightship bell and pneumatic actuating mechanism, without involving the necessity of raising the instrument for examination.

"It is noteworthy that the audibility of the bell is not materially affected by the position assumed by the instrument under water. Even if the bell and its attachments are deflected from the vertical by currents to a considerable extent, the efficiency of the instrument is in no way impaired.

"Bells have also been installed in isolated position at considerable distances from a lighthouse or light-vessel. One such, near the entrance to the channel leading to Boston Harbour, has been in successful operation for over twelve months. The bell is suspended from a submerged iron tripod, placed on the sea bottom in thirteen fathoms of water, at a distance 2½ miles from the shore near Point Allerton, and immediately opposite the Boston lighthouse. In place of the pneumatic actuating gear, a system of electro-magnets is installed, which actuates the clapper. The current is conveyed to the apparatus by cable a distance of over 2½ miles. The entire installation was laid and set to work in one day.

"In regard to the range of audibility of the bells, it is found that a small bell, weighing 140 lb., as now fitted, has been heard at a distance of 16 nautical miles. The range of audibility is largely dependent upon the size and draught of the vessel receiving the signal and the depth of the transmitters below the water-line. A large vessel, such as the Kaiser Wilhelm der II., exposes a very considerable area of ship's hull to the sound waves, with corresponding increment in effect. The signals given by a submarine bell can be frequently heard at distances of two to three miles, without the aid of microphones and receivers by merely placing the ear against some portion of the ship's plating below the water-line. The intensity of the sound is found to be at its maximum when the direction of the bell is about abeam. With the bell straight ahead, the volume of sound is very much reduced, more especially in the case of fine-lined ships. Immediately the vessel deviates from the direction of the bell the intensity is largely increased. These facts were very clearly demonstrated on the occasion of the Trinity House trials on August 12th. It was found that the sound of the light-vessel bell could be heard at moderate distances by an observer stationed in the lower parts of the yacht Irene, and without the use of the instrument. The apparatus was tested at a distance of three miles from the North Goodwin lightship, and again at distances up to five miles, the bell being so distinctly audible at the latter distance that it was evident the limit of range had not been reached. With vessels of the size of a large Atlantic liner the signal should be distinctly heard at a distance of eight miles.

"Among the light-vessels already fitted with bell-ringing apparatus are twelve on the Atlantic coast of the United States between Portland and the Delaware River, four by the Canadian Government on the St. Lawrence or near the mouth of that river, and in Germany the Garbelsflach, which is the outer lightship at Kiel Harbour, the Outer Weser, and the Outer Elbe. The Canadian Government have recently approved a scheme embracing the equipment of twenty-six additional lightship and other stations with submerged bell signals.

"Among the ships fitted with transmitting apparatus are the Kaiser Wilhelm der II., Kaiser Wilhelm der Grosse, Kronprinz Wilhelm, Deutschland, the Lucania, and other vessels of the Cunard and Canadian Pacific lines. The Oceanic and one other vessel of the White Star line are about to be fitted with installations.

"As an instance of the sensitiveness of the microphone apparatus to external sound waves, it is interesting to note that the Deutschland, in June of this year, on nearing Dover Harbour, heard the sound of the divers at work on the national harbour works, and also the beat of the screws of a steamer at a distance of three miles."

HYDRAULIC POWER FROM THE WELLAND CANAL.

POSSIBILITIES OF THE UTILIZATION OF THE DIFFERENCE IN LEVEL BETWEEN LAKE ERIE AND LAKE ONTARIO AT THE WELLAND CANAL.

Alton D. Adams—Electrical Review.

NEARLY all the discussions of the power possibilities of the discharge of the Great Lakes assume that the power generating installations must be placed at or near Niagara Falls, regardless of the fact that the potential energy exists, not by reason of the falls, but because of the difference in level between Lake Ontario and the upper lakes of the chain. Only a portion of this difference in level between Lake Erie and Lake Ontario exists at Niagara Falls, more than one-half being taken up by the upper and lower rapids of the Niagara river, so that a channel or cut-off around the falls would enable a greater amount of power to be developed than is available directly at the cataract. Such a channel already exists in the form of the Welland canal, and the power-generating possibilities of the canal are discussed in a paper by Mr. Alton D. Adams in a recent issue of the *Electrical Review,* from which some of the salient features are here given.

"Welland canal parallels Niagara river in general direction, and connects lakes Erie and Ontario across the strip of Canadian territory about thirty miles wide that lies between them. The canal taps Lake Erie at two points, Port Maitland and Port Colborne, and joins Lake Ontario at Port Dalhousie. Port Colborne is about twenty miles up the Canadian shore of Lake Erie from the head of the Niagara river at Buffalo, but owing to changes in the direction of that stream, Welland canal runs only about eight miles from Niagara Falls. From Lake Erie to Lake Ontario Welland canal drops 327 feet, or from elevation 573 feet on Lake Erie to elevation 246 feet above tide water on Lake Ontario. All save about thirty feet of this fall along the canal takes place between Lake Erie and the foot of the escarpment, where the high Niagara plateau breaks down to the low Ontario plain. From the brow of the escarpment to the Ontario plain at its foot the drop in elevation is as much as 270 feet at numerous points.

"By conducting the water of the upper Welland canal to the brow of the escarpment, which runs nearly parallel with the shore of Lake Ontario, it is thus practicable to maintain a head of water for power purposes that is nearly twice as great as the height of Niagara falls. If Welland canal had its summit level above the surface of Lake Erie, so that only a very limited supply of water could be obtained, the present great opportunity for the development of electric power would not exist. But the summit level of the Welland canal is at its Lake Erie parts, and the supply of water is limited only by what may be drawn from the four upper Great Lakes. The heads of Welland canal on Lake Erie have their mean elevations of 573 feet above tide-water level, and about 327 feet above the surface of Lake Ontario. From Lake Erie the surface of the canal falls slowly to the head lock near Allanburg, Township of Tharold, County of Welland, where its water stands about 325 feet above the Ontario level. This head lock is the highest of the series through which the Welland canal drops to Lake Ontario."

By tapping the Welland canal above the head of the lock near the Niagara escarpment a short canal and pipe line would enable the water to be discharged at a point at the foot of the escarpment nearly at the level of Lake Ontario. Such an undertaking would enable Niagara Falls to be "short-circuited" so to speak, and permit almost any amount of water to be drawn from the upper lakes for power purposes regardless of endeavors to preserve the scenic beauty of the great cataract.

The cost of the construction of the canal and pipe lines and penstocks would be small in comparison with the expensive tunnel and other works which have been incurred at Niagara Falls, but Mr. Adams calls attention to the fact that a reservoir would also be necessary in order to provide for the fluctuations of level in Lake Erie.

"Such storage is readily provided for by leading a comparatively short feeder canal from above the head lock on the Welland canal to a reservoir near the brow of the escarpment, above the point where a generating station is to be located. From a reservoir thus located penstocks may be run down the face of the escarpment to a power-house at its foot. In this way a water head as great as 270 feet on the wheels may readily be obtained. Under this head one cubic foot of water per second develops almost exactly three gross horse-power."

Mr. Adams describes at length the installations which have already been made to use hydraulic power from the Welland canal, especially in connection with the industries of the city of Hamilton. The plant of the Hamilton Cataract Power, Light, and Traction Company is operated by water diverted from the Welland canal at Allanburg, this being operated in connection with a storage reservoir system, and taking 700 cubic feet of water per second from the canal and delivering it to turbines under a head of 268 feet. At the present time this plant has a capacity of 24,300 horse power, with provision for increase to 38,500 horse power, the electrical energy being transmitted thirty-five miles to Hamilton, at 22,500 and 45,000 volts.

"Aside from competition for the markets of Hamilton and Toronto, which promises to be active, it is very probable that smaller cities and towns of Ontario will want their share of electric water power, and Welland canal offers the cheapest means of its development. It is to be remembered too that the amount of electric power which may be consumed in manufacturing industries is not limited by the population in a given territory, as is the case with lighting service. Thus an electrochemical plant that employs less than one hundred men may consume electric energy at the rate of scores of thousands of horse-power.

"New power plants about Niagara Falls must encounter increasing costs and difficulties of construction, as the best locations are already occupied. Along Welland canal and the Niagara escarpment, however, there are numerous opportunities for the diversion of water and the location of generating stations.

"Several new plans are now understood to be under way for the construction of plants that will operate with water from the Welland canal. According to one of these plans, for which surveys have been completed, a power-house is to be located at the foot of the escarpment several miles from St. Catharines, and the water supply is to come from the Welland canal through a short power canal and a large reservoir. From this power plant it is said that transmission lines will extend to Hamilton, Toronto and many smaller places. It would perhaps be unsafe to predict a limit to the diversion of water from Welland canal for power purposes, other than the physical capacity of that canal to deliver water near its head lock. The rate at which water will flow along the Welland canal from Lake Erie to free outlets near the head lock depends, of course, on the cross-section and slope of the canal, and on the nature of its bed. It is quite possible also that this bed would not withstand the eroding action that would follow a constant discharge at the maximum obtainable velocity in the canal. Whatever water rights are granted on the canal, the use of sufficient water for all purposes of navigation will no doubt be reserved. All water drawn from the Welland canal must, of course, come from the upper Great Lakes, and lessens by just so much the volume that passes over Niagara falls. Whether the Welland canal has a sufficient discharge capacity to materially reduce the supply of water at the wheel-pits, tunnels, power canals and pipe lines between the upper and lower river at Niagara Falls remains to be determined."

STEEL DAM CONSTRUCTION.

A DISCUSSION OF THE COMPARATIVE ADVANTAGES OF STEEL AND MASONRY FOR THE CONSTRUCTION OF DAMS.

F. H. Bainbridge—Western Society of Engineers.

THE recent discussions as to the stability of masonry dams, already noticed in these columns, are attracting renewed attention to the desirability of employing structural steel, either in connection with concrete or alone as a desirable method of construction.

The uncertainty which exists as to the real stability of masonry structures, together with their high cost when large dams are required, give the subject both a technical and a commercial interest, so that the investigations now being made into the theory of masonry dams may result in the abandonment of masonry altogether, in favor of forms of construction of a more determinate character. The use of masonry limits the engineer to types in which no tensile stresses are permissible, and while the problem is capable of complete solution when certain conditions are observed, actual practice demands that all the conditions in existence shall be met. In many cases, however, the actual conditions cannot be completely ascertained beforehand, and the extent to which the artificial structure can be bedded in the rock of the foundation, together with the manner in which shearing stresses are resisted, renders it difficult to insure in the actual structure the conditions upon which the computations were based. For these and other reasons engineers are turning to steel as a material for dams, realizing that they have then to deal with a material capable of resisting tension, and in which the direction and concentration of stresses can be more positively controlled, and there are numerous reasons for believing that steel dams will be used hereafter for numerous important installations.

In a paper recently presented before the Western Society of Engineers by Mr. F. H. Bainbridge the construction of steel dams is considered, and the practical information contained in this discussion renders it of immediate value and interest.

About twelve years ago, when Mr. Bainbridge first examined the subject of steel dam construction the price of structural steel was as low as 1 cent per pound in Pittsburg, while at the present time prices are about 75 per cent. greater. At the same time the price of Portland cement has fallen to about one-third what it was in 1894, but in spite of the changes in prices a great economy will be found in the use of steel in many locations.

"For average conditions in the western part of the United States the section of a masonry dam may be taken as equivalent in quantity to a section 8 feet wide at the top and with a base of five-eighths the height. This gives for a dam 100 feet in height an average of 1.3 cubic yards of masonry or concrete per square feet of cross section, which at $8 per cubic yard, gives $10.40 per square foot of cross section. The weight of steel per square foot of cross section will generally be found to be about 1.25 times the height of the section, or 125 pounds for a height of 100 feet, and at 4½ cents per pound erected and painted, there will be a cost of $5.62 per square foot of cross section.

"Again it will be found that in most locations in our Western country where favorable sites for dams exist, a considerable haul by team from the nearest railway is necessary. Considering a cross section 100 feet in height, and assuming 0.8 of a barrel of Portland cement to the cubic yard of rubble masonry, the weight of cement to be hauled will be 400 x 0.8 x 1.3 = 416 pounds per square foot of cross section, as against 125 pounds of steel. It is assumed, in this comparison, that suitable sand and stone will be found at the site, which is seldom the case. For concrete the comparison is still more favorable to the steel.

"It is usually assumed by the uninformed that stone structures subject to the action of air, water, and frost will last indefinitely. As a matter of fact only a small percentage of the stone which is accessible is at all fit for use in structures, and even in the best quarries, the inferior stone which must be wasted or used for riprap, often amounts to 50 per cent. or more of the stone quarried. In a dam, especially in cold climates, stone is subjected to most trying conditions and untried local stone should be used only with the greatest caution.

"So far as present experience goes Portland cement concrete for dams appears to be a safer material, but it must be remembered that concrete setting in air contracts in volume, and in large masses cracks are almost certain to result. For this reason concrete for large dams must first be cast in blocks and set in mortar joints after being dried out. Under certain conditions reinforced concrete for high dams appears to be a promising material, especially where an arched form is permissible, and its first use in this direction will be awaited with considerable interest. A number of low dams have been built of reinforced concrete, but as questions of economy limit the use of steel to high dams, such only are here considered.

"While stonework, in common acceptance, has an undeserved reputation for permanence and stability, steel has an equally undeserved reputation for deterioration. The reason for this is plain. Opportunities for observing the weathering of steel are most frequent in large cities where the air is laden with sulphuric and carbonic acid gases. Iron, water, rust, is usually looked upon as a necessary sequence, but observations on stand-pipes and dams built of steel show that reasonably pure water alone has little effect in corroding steel, and that under water a good paint is a first-class protection."

Mr. Bainbridge describes the 42 feet high steel dam at Ash Fork, Arizona, which was completed in 1898, and which, with a careful painting with oil, red lead, and graphite paint at the time of erection showed no indication of rust after four years. As this is believed to be the first fixed metallic dam ever constructed some details will be of interest.

"The steel portion of the dam is 184 feet long on top and the whole dam is about 300 feet in length, including short masonry abutments at each end. Structurally it consists of a series of triangular steel bents resting on concrete foundations and carrying steel face plates on the inclined or upstream end. No spillway or waste weir is provided, the dam being designed to permit a flow of 6 feet depth of water over the crest. Since its construction a maximum flow of 4 feet has been observed. To prevent the overflow from undermining the foundations, loose rock is piled at the base to break the force of the falling water. However, overflow to any considerable extent is a matter of rare occurrence.

"The structure is composed of alternate

rigid and loose panels. The crest or apron plates which fit the braced panels between the bents are riveted to a curved angle which is riveted to the upper end of the curved plate, while in the unbraced panel this angle merely bears on the apron plate. By this means the forces which would result from longitudinal expansion and contraction and which would be fatal to the structure are avoided. The face of the dam is composed of steel plates ⅜-inch thick and 8 feet 10⅝-inches wide, riveted to the outer flanges of the inclined I-beams of the bents. The plates are mainly 8 feet in length, curved to a radius of 7 feet 6 inches, forming a series of gullies or channels down the face and leaving a flat portion which rests on and is riveted to the I-beams. The curved plates, however, do not extend into the concrete of the toe, but are replaced by flat plates in the bottom course, the bottom plates being dished."

The steel dam with concrete foundations, built at Redridge, Michigan, was completed in 1901, and has been in satisfactory service ever since, and in addition to these two existing examples Mr. Bainbridge describes a typical bent for a 100 foot steel dam, showing the bracing and distribution of the stresses.

SIMPLON-TUNNEL CONNECTIONS.

THE COMPLETION OF THE SIMPLON TUNNEL AND THE RELATION OF ITS CONNECTIONS TO THE RAILWAYS OF FRANCE.

La Revue Technique—Schweizerische Bauzeitung.

THE announcement of the junction of the headings of the Simplon tunnel in February last by no means indicated that the great work was wholly completed. Since that date, however, steady progress has been made, and the questions of the best railway connections to enable the full benefit of the new passage through the Alps is again being agitated. In recent issues of the *Schweizerische Bauzeitung* the details of the completion of the actual tunnel are recorded, while a review in *La Revue Technique* continues the discussion of the French railway connections to the new route to Italy and the East.

Dr. M. Rosenmund, writing in the *Schweizerische Bauzeitung,* discusses the accuracy with which the alignment of the tunnel was verified by the completed work. Notwithstanding the fact that the tunnel was longer than any which has yet been undertaken, and that its construction was attended with many unforeseen difficulties, the junction of the headings revealed a high degree of precision in the work. The first determinations of the lines of the tunnel after the opening of communication showed a difference of only 9 centimetres between the two levels, or about 3½ inches, while the lateral deviation was found to be 5 centimetres, or less than 2 inches. Later measurements confirmed the accuracy of the vertical alignment, but more careful examination, after the mist arising from the hot springs had been removed by forced ventilation showed a slightly greater error in the lateral direction, the lines passing each other by about 9 inches in the middle of the tunnel.

So far as the actual length is concerned the measured length between base points was found to be 0.79 metre less than that computed for triangulation, this being in a length of nearly 20,000 metres, or 31 inches in twelve and a quarter miles.

The present state of the work on the tunnel gives assurance that it will be ready for service by the beginning of 1906, and it is this fact which forms the keynote of the paper in *La Revue Technique* by M. Paul Olivier Lacroye. Something must be done if the commerce of France is to profit by the opening of the new route, and the time in which to do it has already arrived. The Swiss connection of the tunnel is the Simplon-Jura Railway, which skirts the northern bank of the lake of Geneva, passing through Lausanne to Geneva, and provided thence with connections to the Paris-Lyons-Mediterranean Railway, but this is but an indirect communication to the north, and unable to compete with existing routes, so that a better and shorter, and more direct communication must be provided if the course of traffic is to be diverted.

Broadly there are two viewpoints from

which the Simplon connection can be regarded. Of these one considers only the desirability of providing a direct communication from the tunnel to Paris and to the North Sea ports, while the other includes a realization of the fact that Paris is not everything, and that it is important to provide a direct trunk route across France at its narrowest part and provide direct communication with the Atlantic.

As a consequence of these two independent ideas there are two plans for connection with the Simplon which are under consideration, one of these being known as the Frasne-Vallorbes line, and the other the line of the Faucille. The first of these includes communication with Paris and with the North Sea ports, and it has been proposed as a substitute for the so-called Pontarlier route, which already exists, but which is subject to the objections of high altitude, difficult curves, and frequent interruptions by reason of snow. By the construction of the short connection between Vallorbe and Frasnier the line from Milan to Paris by the Simplon is reduced to a distance of 830 kilometres. It is true that various objections to this plan have been advanced, and it is evident that the connection would be improved by extending the new line from Frasne to Joux, thus reducing the grades and curves. One of the principal recommendations of the plan is its moderate cost, the share of Switzerland being 7,000,000 to 8,000,000 francs, and that of France about 20,000,000 francs.

The other plan, that of the route by the Col de la Faucille, ignores Paris, and is based upon the importance of making a direct connection between Italy and the Atlantic by way of the Simplon, thus forming a trunk line across France. This route, it is true, involves the boring of another tunnel and the construction of some difficult work, but it would provide France with a line which could not fail to increase her commercial importance. By giving a direct route from Italy and the East to the Atlantic, including access to a port such as that of St. Nazaire, it would enable France to compete with Germany as regards transatlantic service, and effect a transformation in much of the commerce between Europe and America.

The line by Frasne-Vallorbes is all right for communication between Italy, France, and England, but this is a route already well served. If France is fully aroused to her opportunity she cannot fail to realize that the great opportunity before her is to leave Germany upon one side and to provide a through route from the east, via the Simplon tunnel, to the Atlantic, and to use the Atlantic terminus as the port for a first-class steamship line, either that which now runs from Havre, or an entirely new line from St. Nazaire to compete effectively with the German lines, and, in connection with the trunk railway line across France, to control a great portion of the commerce which now goes by other routes.

DUST PREVENTION ON HIGHWAYS.

IMPROVED METHODS OF DESIGN FOR MINIMISING THE DUST-RAISING ACTION OF AUTOMOBILE VEHICLES.

W. R. Cooper—Nature.

DUST has always been more or less of a nuisance in connection with highway travel, especially in dry weather, but the problem of dust prevention has been so emphasised by the introduction of the high-speed automobile that it is demanding the best skill of the engineer to devise means which shall be both effective and commercially practicable. A review of the methods which have thus far been considered, together with an account of experimental researches into the phenomena of dust raising is given in a paper published in a recent issue of *Nature* by Mr. W. R. Cooper.

"At the present time by far the most serious problem which the automobilist has to face is the abatement of the dust nuisance. A great deal of bad feeling has arisen against the motorist on account of the dust which he too frequently produces, and there is no doubt that there are very good grounds for the irritation which has arisen, more particularly in agricultural districts. Farming in England, at the best of times, is not in a prosperous condition, and a farmer does not view with any kindly eye a further reduction in his produce through the effects of dust. Apart from that, however, dust may cause a great deal of personal discomfort to other users of the roads; but this phase of the question would, perhaps, not require very serious consideration were it not that dust of this nature is apt to carry disease, and to lower the health of the poorer part of our population living along the main thoroughfares. As such matters may lead to serious opposition to automobilism, and possibly to further legal restrictions, all tending to hamper a growing and very important industry in this country, it is becoming imperative to see what can be done to minimise a nuisance of this kind.

"At present there are two distinct methods of tackling the problem. On is to treat the roads, or construct them, in some way so that they no longer give rise to dust. The other is to so alter the construction of the car that dust, if it exists, will not be raised to a serious extent."

The question of the treatment of the roads has been under practical consideration for a long time, and the ordinary watering cart is doubtless the earliest example of this department of the work. The effect of the water is but temporary, however, and when the water is used in excess, as is usually the case, the result is injurious to the road. Other materials than water have been tried, deliquescent salts being suggested, while a certain measure of success has been attained by treating the surface of the road with oil. Mixtures of petroleum and ammonia have been used with some success, while in California the treatment of the roads with crude petroleum has been very effective in preventing the formation of dust. The nature of the oil employed seems to have a material influence upon the success of the operation, and it is necessary that the petroleum and the road material should bind together to form a tough and strong surfacing. This probably explains the non-success, or only partial success which has attended attempts at oiling roads in Great Britain. A similar experience is had with the use of tar. A permanent result can only be obtained by the formation of a waterproof crust to a fair depth, so that the dust forming materials cannot work up, and this can be obtained only by combining the tar with the materials used in the construction of the road.

Such a material as granite or syenite can be improved only temporarily by the application of tar, the coating rapidly wearing off. A surfacing of porous furnace slag and tar is found to give a good dustless road, the broken slag being thrown into the tar while hot, and the pores becoming so thoroughly impregnated as to render the material a dustless surfacing.

All methods of treating the surfaces of the road are necessarily limited in scope, owing to considerations of cost and time, and while the roads within and adjacent to towns and villages may be thus improved it is impracticable to give the same attention to the extended country routes so extensively used in touring.

Attention has more recently been directed to the fact that it is possible to minimise very greatly the production of dust by modifications in the design and construction of the car, and this opens a fertile field for investigation and study. In many instances the alteration of some trifling detail has resulted in great improvement, such, for example, as the change of direction of a downward pointed exhaust to a position in which it will not stir up the dust.

"Speaking generally, and leaving such special points as direction of exhaust out of account, it may be said that the dust is raised by the tyres, and is then scattered by the air currents produced by the body. In other words, if the body were moved along the road at its normal height, supported by other means than the wheels, very little dust would result. But it is equally true that if the wheels could be run without the body there would not be much cause for complaint as to dust. By *body* is here meant the whole structure, apart from the wheels, so that the term is more comprehensive than usual. The passage of a car body through the air necessarily creates a great deal of disturbance, and the extent to which the air near the ground is disturbed must depend to a great extent upon the shape of the body. The less the disturbance, the less will the dust be formed into a cloud.

"In 1903, the Automobile Club tested the dust-raising qualities of a large number of cars. Each car was run at twenty miles per hour over a patch of flour on the cycle track at the Crystal Palace. The flour was kept at a definite thickness, and as each car passed it was photographed. These photographs gave a permanent record of the dust cloud raised by each car, enabling the committee to classify the cars in the order of merit. The records so obtained gave a great deal of useful information, and it was recognised that this method of testing was far more satisfactory than optical observations, because an observer has a good deal of difficulty in retaining a mental picture of what may be termed a standard car as regards dust.

"In a paper read in 1903 before the Automobile Club, Colonel Crompton and Mr. Crawley came to the following conclusions, based on these experiments:—Hard tyres are better than soft; narrow tyres are better than broad; neither have a preponderating influence; flaring mud-guards are probably bad, especially if they come low down; cars which are low underneath are worse than cars a long way off the ground; but smoothness of bottom-shape and absence of forward-coning are infinitely more important. There is strong evidence that it is desirable that the car should slope upwards towards the back. At the same time, the authors point out that a low car is not necessarily a dusty one, nor is a high car necessarily dustless."

Preconceived ideas with regard to the production of dust are not entirely borne out by the results of experiments, and in Mr. Cooper's article there are given a number of photographs which are much more valuable than any general theorising about the subject of dust raising. In order to eliminate extraneous elements, Mr. Cooper constructed a special apparatus, consisting of a form of tricycle, with two small leading wheels, and a single trailing wheel of ordinary bicycle type, the whole having a light skeleton frame, this vehicle being arranged to be drawn at speeds of fifteen to twenty miles an hour over a track laid with flour.

By attaching various fixtures to the vehicle it has been possible to photograph the effect of distance from the ground of the lower portions of a car, while screens, inclined planes, and similar attachments may have their effects recorded. The influence of hard and soft tyres has also been studied, and a foundation laid for a scientific study of the whole problem.

"Although, from the point of view of raising dust, the tyres may not be so important as the body, their action does seem to be important enough to warrant more careful investigation. They are capable, in themselves, of raising a good deal of dust, as is often to be seen in the case of bicycles. Very possibly dust is carried up by tyres through a kind of suction, and this may vary a good deal with the design. Now that there are so many different tyres, including non-skidding bands, on the market, there is likely to be a considerable difference in the various types as regards dust. In the photographs which are reproduced, the wheel is equivalent to the front wheels of a car, as there is no driving force on the tyre. In the case of wheels which are drivers, there will be a certain amount of slip of one kind or another, and the dust raised is likely to be greater; but, actually, there does not seem to be any very great difference between drivers and non-drivers—at least there is much less than would be expected."

In general the influence of the body of an automobile upon the raising of dust appears to be determined partly by the presence of irregularities beneath. An inclined plane, so placed as to direct the air severely down upon the track, did not appear to produce as much dust as might have been expected, while a square box placed at 9 inches above the surface of the road raised a noticeable amount of dust, this corresponding somewhat to the tool box of an automobile, such boxes often being still closer to the ground.

An examination of the photographs in Mr. Cooper's paper indicates very clearly the possibilities which exist for improvement in design as regards dust raising properties, and for touring machines especially this is a feature which may well occupy the attention of the builders of automobiles as an important element in design and construction.

APPLICATIONS OF POWER GAS.

THE USE OF GASEOUS FUEL FOR THE GENERATION OF POWER AND THE PRODUCTION OF HEAT.

Ernest A. Dowson—Birmingham Association of Mechanical Engineers.

ALTHOUGH many papers and articles have been written of late upon the subject of gas power, most of these have been devoted either to the discussion of some especial form of generator or producer, or to descriptions of different kinds of gas engines.

A much broader treatment of the question appears in a paper recently presented before the Birmingham Association of Mechanical Engineers by Mr. Ernest A. Dowson, this being a general review of the use of gas for power and heating purposes, without advocating any special forms of appliances for the purpose.

Assuming that the gas engine has passed out of the experimental stage and that no apology is needed on its behalf, Mr. Dowson simply calls attention to the facts that not only is the thermal efficiency of the gas engine fully double that of a high-class steam engine, but that in practice the gain is far greater because only a few first-class steam engines of large size realize even good working efficiency. Any comparison between steam and gas power should include all the elements of the respective plants; the boiler, piping, engine, and auxiliaries, on the one hand, being compared with the producer and generating appliances, and the gas engine, on the other part. In such case the advantages of the gas plant will be seen to be even greater than appears by comparing the engine performances alone.

Omitting from consideration the vapors of liquid hydrocarbons, Mr. Dowson examines various kinds of power gas, these including ordinary illuminating gas, or, as it is sometimes called "town gas"; producer gas; water gas; and semi-water gas. Under the term producer gas is included not only the lean gas obtained by the partial combustion of fuel to carbon monoxide, but also the waste gases from blast furnaces, this being practically of the same composition and properties.

Plain water gas, formed by the interaction of steam and incandescent carbon, is a valuable fuel for heating furnaces and special purposes, the large percentage of hydrogen giving it a high flame temperature. It is, however, not well adapted for use in gas engines, since the excess of hydrogen causes a high rapidity of flame propogation, producing violent explosions and heavy shocks to the engine, while the use of the most advantageous compression is impracticable, owing to danger of pre-ignition.

Excellent results are obtained with semi-water gas, this being practically a combination of producer gas and water gas, obtained by passing a mixture of air and superheated steam or even saturated steam through an incandescent bed of coal or coke. Such a gas contains 16 to 18 per cent. of hydrogen, instead of 50 per cent. as in straight water gas, together with about 25 per cent. of carbon monoxide.

"For making gas for driving engines, the *best* results have been obtained when the fuel is either small anthracite pea or ordinary gas coke, but latterly something has been done in the way of using ordinary hard, non-caking, bituminous coals, which in some districts are cheaper than the former. It must, however, be remembered that a mere comparison of the prices of the raw fuels per ton does not constitute a complete basis from which to compute the relative costs of a brake horse-power hour obtained in any given cases. Fuels other than the two first mentioned have certain drawbacks, especially in plants of average size. The removal of the tar which is found in gas made from any bituminous fuel requires more extensive cleaning apparatus, part of which generally needs engine power to drive it, while the water consumption is incresed for the same reason, in addition to which it is distinctly a dirty process. It is a mistake to suppose that *any* class of slack coal may be employed, even in large installations. All coalfields do not yield fuel which will give good results in gas making. Bituminous coals are not of so uniform a quality as are those of the anthracite class, and they will always be more troublesome to deal with than are the latter. Some coals are very apt to hang up in the generators, which, besides causing troubles in working, inevitably leads to variations in the quality of the gas made. More labor is always involved in the gasification of bituminous fuels, and a certain element of risk is introduced of tar getting over to the engines on occasion. When this occurs much trouble is experienced by the gumming up of the valves and other working parts, causing serious delay and loss."

If bituminous fuel is to be used it is best to install a complete scrubbing and washing plant, in which case a by-product recovery system, such as devised by Dr. Mond, may be found profitable. Such plants, however, are better adapted for large central stations than for the individual user, and the smaller plants are best designed on the suction principle, the gas engine itself acting to draw the air and steam through the fuel.

"The fuel consumption is extremely low, as instanced by tests which have shewn a figure as low as .8 lbs. per brake horse-power per hour of small anthracite of commercial quality, such as can be obtained in Birmingham at about 18 shillings per ton. The water required for gas making and cooling does not exceed about 6 pints per hourly brake horse-power. Beyond this, an allowance for attendance must be made, and for a plant of, say 100 brake horse-power, the time required is about 2 hours daily for one man. The small space occupied is also an important feature, and this is, roughly, equal to about half a square foot for each brake horse-power capacity. Installations of this type of plant are at work where the power is utilized in driving dynamos, supplying current for both electric lighting and power, and the fact that the *whole station costs* have worked out at from ½d. to ¾d. per unit shows the really remarkable economy of the system."

Mr. Dowson reviews rapidly the construction of various types of gas engines as made in Great Britain and on the Continent, including both the four-cycle and the two-cycle types, referring especially to large engines for electric generating stations and iron works.

"It is well known that in all gas engines of large dimensions the greatest troubles experienced are those arising from the high flames temperature incidental to the explosion. Rapid cooling of the charge must therefore be resorted to in order to protect the working parts. The aggregate of the expansion of the metal forming the combustion chamber and cylinder becomes, in a large engine, a very appreciable amount. It is therefore extremely advisable to leave all this metal as free to expand as possible. This is, however, rather a difficult problem, as, taking the combustion chamber for instance, the inlet and exhaust ports, together with others for the ignition apparatus and the starting apparatus, must in any case be provided. For this reason valveless engines, such as the Oechelhäuser, are easier dealt with in this particular.

"Continental makers of large gas engines have gone in for great elaborations in the way of water cooling in order to get rid of these temperature difficulties. With great ingenuity they have arranged to water-cool the pistons and piston rods in the double-acting engines, in addition to the ordinary cylinder jacket. The exhaust valves and their casings are also ingeniously water jacketed in most of these engines. It need hardly be pointed out, however, that the many complicated devices thus needed introduce additional risks of failure, and it is reasonable to look upon them as a merely temporary endeavor to make a working engine of large power. In view of these facts it really appears to practical engineers that the best way of building such an engine is to replace the large single cylinder by several of moderate size, say three or four, each of which we know from experience is capable of being worked over long periods without any chance of breakdown."

The use of gas for heating purposes in manufacturing is extending continually and the advantages of such a clean, efficient and controllable fuel are incontestable. The late Sir William Siemens is quoted as saying: "I consider it perfectly barbarous to use coal for any purpose in its crude state, and believe the time will come when all crude fuel will be separated into its component parts before it reaches our habitations."

"As has already been insisted upon in connection with power plants, it is necessary to exercise a good deal of judgment in each case as it occurs, and this is even almost a stronger necessity where heating is required. In the first place, it is necessary to decide whether or not the installation of a gas plant *is justified* by all the circumstances. Obviously, if any given appliance, at present coal-fired, shows a very high thermal efficiency, one has hardly a prima facie case for recommending the change. Of course there may be other incidental reasons for deciding in the affirmative, such, for example, as increased convenience and cleanliness, reduced attendance, etc., and these last named are frequently very important. Even when one has decided on the change, open questions still remain, not only as to the make up of the gas plant, but also to the exact way in which the gas shall be applied to the work in view. The method that gives good results in one case will perhaps totally fail in another, and this has brought it about that in some instances failure to effect the hoped-for economy has led users to discard gas firing as a failure altogether. This need never occur if the normal working programme has been carefully considered from the outset, and the heating appliances properly designed."

Although water gas, from its high calorific power, is best for heavy welding purposes and special uses, semi-water gas is generally to be preferred because of its cheapness. By its use temperatures above 2,000 degrees F. can be obtained in a crucible furnace without using any air blast, employing the cold gas from a main, while much higher temperatures can be attained with a blast and superheated gas.

Mr. Dowson's paper contains much valuable information concerning costs and installation methods for gas plants, and forms a valuable contribution to the technical literature of an important department of engineering work.

APPLICATIONS OF SUPERHEATED STEAM.

DATA AND RESULTS OF RECENT EXPERIMENTS IN FRANCE UPON THE ECONOMY OF SUPERHEATED STEAM IN RECIPROCATING ENGINES.

Ch. Compère—Société des Ingénieurs Civils de France.

IN a recent communication made by M. Ch. Compère before the mechanical section of the *Société des Ingénieurs Civils de France,* and published in the *Mémoires* of the society, there is given a general review of recent progress in superheating, the information being largely drawn from French experiments of late date.

At the time of the Düsseldorf exhibition in 1902 M. Compère examined the performance of the steam engines there exhibited, and called attention at that time to the fact that superheating was much more widely used in Germany than in France, the consequent efficiency of such engines attaining a consumption of 4.49 kilogrammes, or 9.9 pounds, of steam per horse power per hour for an engine of 300 horse power, using steam superheated 300 degrees C. Although such results have been attained by engines under tests they are by no means common in everyday service, and M. Compère proceeds to examine the conditions which surround the use of superheated steam.

In the first place it must be remembered that the steam engine, as invented by Watt and as actually used at the present time, includes the engine, the boiler, and the communicating piping. This fact is often lost sight of since the specialization in construction has separated the manufacture of the several portions of the motive-power machine, and has led to their independent development.

It is for such reasons that we find, for instance, the builder of an engine guaranteeing a performance conditioned upon the delivery to the engine of steam of a certain pressure and degree of superheat; or, again, for efficiency guarantees to be given for the engine and boiler separately, without taking into account the losses which occur in a long line of pipe. For such reasons M. Compère emphasises the necessity of considering an installation as a whole in examining the practical performance of a plant using superheated steam.

In Germany it is common to use lift, or

poppet valves, and it is sometimes assumed that slide valves, either of plain or the Corliss type, are unsuited for use with superheated steam. In France the poppet valve is not often employed, both because of the greater clearance which it requires, and because it is generally believed to be less economical than the slide valve, although the recent experiments in England indicate that leakage losses from slide valves are more serious than has been generally supposed.

M. Compère gives in detail the results of several trials of engines in France with superheated steam, these being made upon engines fitted with Corliss valves. For the details of these trials reference must be made to the original paper, but the results may be given here, together with some of the conclusions drawn.

Thus, with a Corliss engine of 140 horse power, built by MM. Weyher & Richemond, of Pantin, arranged to be supplied with either saturated or superheated steam, operating at pressures of 6 to 7 kilogrammes per square centimetre (85 to 100 pounds per square inch) working with and without a steam jacket, the following results were obtained.

Operating with saturated steam, a consumption of 6.85 kilogrammes of steam (15.1 pounds) was required per horse power per hour, a very excellent performance for a single-cylinder engine of this size; the steam jacket being in use. With the steam superheated about 260 degrees C. this consumption was lowered to 5.865 kilogrammes (12.92 pounds), the jacket still being in use, while with the same degree of superheating, but without the jacket, the consumption was still further lowered to 5.68 kilogrammes (12.52 pounds).

This question of the influence of superheating upon the economy of jacketing has already been observed, but M. Compère examines it in an interesting manner, and shows the conditions under which jackets are or are not of advantage. The jacket acts as a transmitter of heat, and with saturated steam or with steam which is only slightly superheated the gain by transfer of heat to the cylinder is greater than the loss by transfer from the outside of the jacket to the atmosphere. With higher degrees of superheat, however, the external losses overbalance the internal gains, and it is more advantageous to keep the superheated steam up to its maximum temperature until it enters the cylinder, rather than to permit it to lose a portion of its heat in the jacket. By a graphical diagram based upon the experiments with the Weyher & Richemond engine M. Compère shows the relation which superheating bears to jacketing. Without a jacket the economy due to superheating appears at once, and the gain appears to follow nearly a straight-line law, the steam consumption falling almost in direct proportion to the increase in superheat, at least within the range of the experiments, which extended up to 270 degrees C. superheat. With the steam jacket, however, a large portion of the economy effected by early stages of superheating has already been secured, and there is practically no gain up to a superheat of about 210 degrees C. At this point, however, the two lines intersect, the curve showing the consumption without the jacket being below the jacket curve, and beyond a superheat of 230 degrees C. the two lines run nearly parallel, the economy of superheat without jacket running about 0.35 kilogramme, or 0.77 pound, of steam per horse power per hour better than with the jacket.

These observations compare favorably with those of M. Vanderstegen, except that the latter engineer fixed the point at which the jacket ceased to be of benefit at 250 degrees C., while M. Compère finds it to take place at the lower point of 210 degrees.

The question of the efficiency of superheated steam in jackets is closely allied to the subject of losses in pipe transmission.

The experimental investigations of Dr. Berner in Germany, as well as practical experience elsewhere, shows that much greater care is necessary in covering steam pipes and protecting against radiation losses with superheated than with ordinary saturated steam. The excess heat which is conveniently given to the steam is also readily lost and this applies to the steam pipes as well as to the jacket. M. Compère cites a case in which steam superheated to 320 degrees C. at the boiler lost 100 degrees in transmission through a distance of 46 metres, and it was found impracticable to maintain more than 200 to 220 degrees superheat at the engine. The only available remedy was the removal of the boiler to a position close to the engine. This fact doubtless explains in part the high economy of the Wolf semi-portable engine, the cylinders being mounted directly upon the boiler and the steam passing directly from the superheater to the cylinder without opportunity of radiation losses.

M. Compère discusses the question of independently-fired superheaters as compared with superheaters placed in the boiler flue.

In general there is less gain in fuel by the use of the independently-fired superheater, but this is frequently made up by the greater facility of control and the lower repair expense. Practical advantages may be indicated for either type, but in everyday practice the independent superheater is found to possess material advantages. Care must be taken in the design of the independent superheater to utilize the heat to full advantage, and many designs permit the gases to escape at a higher temperature than is consistent with best superheater efficiency.

In order that the real benefits of superheating may be attained in actual practice it is necessary that the installation be considered on its merits and the details worked out for the local conditions. The whole plant must be taken into account, including boiler, connections, and engine, otherwise the gain in one portion may be neutralized by the losses in another. The influence of high temperatures upon tightness of joints and packings must not be overlooked, and the influence of the heat upon the valves considered, both as regards leakage and danger of sticking. Unless such precautions are taken it will be found that the undoubted advantages of superheating, as shown in scientific tests, will not be borne out in daily service, while with suitable exercise of judgment and care the gain may be fully realized.

CONCRETE BUILDING CONSTRUCTION.

EXTENDING APPLICATIONS OF HOLLOW CONCRETE BLOCKS FOR BUILDING AND ENGINEERING STRUCTURES.

S. B. Newberry—Cement.

THE increasing use of cement, either in the form of ordinary or reinforced concrete is one of the significant features in current engineering progress. Some small indication of the growth of these applications may be found from the bald statement of the fact that the production of cement in the United States has increased three-fold in the years from 1900 to 1905, and while this increase has been due to more than one cause there is no doubt that a large part of the demand has come from the extending applications of concrete in construction. An important element in the growth of concrete work is found in the use of various forms of concrete blocks, and this branch of the art forms the subject of a valuable issue of *Cement,* from which we make some abstracts.

"The cause of this remarkable development of a new material of construction is chiefly to be found in the rapidly failing supply of lumber, together with the widespread public interest in all applications of Portland cement. The advance of more than 50 per cent. in the price of lumber during the past few years has been a serious hardship and obstacle to the increasing multitude of people who aspire to having homes of their own, and it is but natural that builders should look about for some efficient substitute for wood, and should look with favor on a material which offers advantages of durability, safety, comfort and beauty which are unknown in frame construction.

"There is good reason to believe that this efficient substitute for wood has been found in the hollow concrete block, and that we are still only on the threshold of the development of this building material. Opposition to its use on the part of the consumer is not to be feared; the obstacles to be overcome lie chiefly in the danger of careless or ignorant work by blockmakers and builders, and in the need of study and invention to adapt the material to the economical production of convenient and beautiful structures. There is every reason why concrete should become the chief building material of the future. For large and costly buildings it is likely that solid concrete, plain or reinforced, will have the preference. For smaller structures, especially factories and dwellings, hollow blocks are certainly cheaper, more suitable, and require much less technical skill in erection. The possibilities of this type of construction seem to be unlimited."

Mr. Newberry discusses briefly the history of hollow concrete blocks in construction, showing that although solid blocks were employed in the early part of the nineteenth century the advantages of the hollow form did not appear until much later. According to Mr. Newberry, the use of hollow concrete blocks, to be filled up with concrete after being placed in position, was patented by Sellars, in England, in 1875, but we believe that very large blocks of this kind were employed in the construction of the breakwater piers at the Port Said entrance of the Suez canal, several years before. However this may be, there is no doubt that the hollow block of concrete possesses many advantages, and that its development as a standard article of manufacture at a recent date has placed a most valuable material in the hands of the engineer and builder.

An essential element in the commercial manufacture of hollow concrete blocks is the modern block machine, the credit for which Mr. Newberry gives to Mr. H. S. Palmer, although there are numerous well-designed machines now on the market.

"Portland cement, owing to its uniformity, strength, and especially its promptness in hardening, is the only hydraulic material which finds any considerable use in block making. A great point in favor of Portland cement is that it gains at least as great strength in air as in water; other hydraulic cements are generally unsuitable for work not kept permanently wet. At the present moderate price of Portland it is certainly cheaper in use, for a given strength, than any of its substitutes.

"The aggregate, or inert coarse material used with cement to produce concrete for blocks, may be either sand and gravel or stone screenings. There is little choice between these two classes of material, if of good quality. Sand and gravel are generally cheaper, and are usually somewhat easier to perfectly mix with the cement. In the matter of strength and hardness of the resulting blocks there appears to be little or no difference.

"The strength of concrete depends greatly on the density of the mixture, and this is chiefly a question of voids in the aggregate used. It is well known that a mixture of cement and sand is weaker than the same mixture with the addition of coarse gravel. For example, a mixture of cement 1, sand 3 will show a lower strength than cement 1, sand 3 and gravel 4, though the latter mixture contains only half as much cement as the former. This is due to the reduction of the voids in the mass by the addition of coarse gravel."

In the manufacture of concrete blocks Mr. Newberry emphasises the advantages of the use of a certain proportion of coarse gravel or screenings instead of sand, and also shows that there is an advantage in adding slaked lime to the mixture, this cement 1, sand 3 will show a lower strength and lessening the penetration of water. A good proportion is: cement 1, hydrate lime ½, sand and gravel 6. A proper amount of water is essential, and the mixture should be as wet as it can be without sticking to the plates, and without sagging or becoming distorted when taken from the machine. Mixing machines are especially to be desired, in order to secure a uniform mixture, and batch mixers are to be preferred to continuous machines.

When Portland cement concrete blocks are well made, of good sand and gravel or limestone screenings, they should have a compression strength of more than 2,000 pounds per square inch at four weeks, and more than 3,000 pounds after one year.

"One of the chief faults often observed in work done with concrete blocks is their tendency to absorb water to such an extent as to cause dampness to appear on the interior surface. This is especially noticeable in blocks poor in cement and made too dry. The fault may be overcome by use of suitable materials and sufficient care in manufacture.

"The terms porosity, and permeability, are often used, and by many supposed to be of the same meaning. The porosity of concrete is, however, the proportion of voids, or empty spaces, which it contains, while the permeability is the rate of speed with which water, under a certain pressure, will pass through it. All concretes and mortars are more or less porous, and all are somewhat permeable by water under heavy pressure. It is well known that, with the same proportion of cement, mixtures of fine sand are more porous than those of coarse sand. The latter are, however, much more permeable than the former. Feret has shown that the porosity is the total amount of voids contained in the mass, while the permeability depends on the size of the individual openings. The least porous concrete may, therefore, be the most permeable, and vice versa. If, however, both fine and coarse grains are present in proper proportion, the mass will show the least porosity and at the same time be the least permeable. The concrete which best resists water will therefore be that which is most dense, provided a sufficient amount of fine grains are present."

So far as the important question of cost is concerned, Mr. Newberry gives a computation of costs of blocks 9 inches high, 32 inches long, and 8 inches wide, amounting to 22.5 cents apiece, with cement at $1.50 per barrel, such blocks selling at about 30 cents apiece, or higher in localities where brick and stone are costly.

In general it appears that a finished wall, such as can readily be laid with concrete blocks, will cost about one-half that of a common brick wall, while the cost of stone is practically prohibitive in comparison.

"Those who can make blocks for their own use, as at large factories where much building is done, can make and lay them at a cost far below that above stated. Laborers can be put to work making blocks when not otherwise employed, and a stock thus constantly kept in readiness. At localities where sand and gravel are to be had for the cost of hauling, 8-inch blocks of 1 1-3 cubic feet can be made at a cost of 15 cents each and laid up for 5 cents more, making total cost of wall of 15 cents per cubic foot, or about half that of common brick. The convenience, durability, beauty and economy of this type of construction, for industrial purposes, is so great that no manufacturer who has made trial of it will ever want to use anything else in making additions to his works."

INDUSTRIAL AUTOMOBILES.

RECENT DESIGNS OF INDUSTRIAL AND MILITARY AUTOMOBILES AT THE COMPETITIVE TRIALS OF THE AUTOMOBILE CLUB OF FRANCE.

Ch. Dantin—Génie Civil.

DURING July and August of this year there was held under the auspices of the Automobile Club of France an interesting series of competitive trials of vehicles adapted for industrial and military purposes. The results were both interesting and important, showing the extensive development which has taken place in this class of automobiles, and hence the extended account of the vehicles exhibited, as given in *Le Génie Civil* by M. Ch. Dantin forms a desirable contribution to technical literature.

The industrial vehicles were divided into two classes, the first including those intended for the public transport of passengers, and those carrying up to 500 kilogrammes of merchandise; the second class covered vehicles carrying more than 500 kilogrammes of merchandise. The military vehicles were subjected to the same tests as the second class of industrial automobiles, but were considered as forming a separate class, the Ministry of War uniting with the Automobile Club in the conduct of the trials.

The tests included the completion of a circular road tour, starting from Paris, and passing through Amiens, Dieppe, Havre, and Rouen, back to Paris again, this circuit making a total of about 875 kilometres, or more than 540 miles for the lighter vehicles, and a somewhat shorter route for the heavy machines included in the second class. The daily allotment of distance varied from 50 to 150 kilometres, stop of one or two days being made at the larger cities to permit exhibitions of the competing vehicles to be held.

The trials were successfully held from

July 28 to August 8, and of the 56 vehicles which started all but four completed the circuit. Of the four which failed three met with unavoidable accidents from external causes, so that the trials demonstrated the general reliability of the various machines in a high degree.

In his papers M. Dantin describes the different machines, photographs also being given, but we can give but a general account of the leading types here, with some comments upon the broad results. The omnibuses resembled for the most part the typical horse-drawn omnibus of Paris, although in some cases the influence of the touring car upon the design was evident.

A number of light delivery wagons were included among the entries in the first class, but the vehicles of the most importance were the trucks, lurries and military wagons.

With the exception of the Serpollet machines, which were constructed with that engineer's well-known flash boiler and steam-engine, the vehicles were all equipped with gasoline motors, but it is a matter for comment that in numerous cases the engines and carburetters were also adapted to be used with alcohol.

Pneumatic tires were used in but few examples, solid rubber tires being the rule, while iron tires were also employed.

Full details of the performances of the various machines cannot be given until the full report of the technical commission of the Automobile Club is completed. At the same time M. Dantin is able to make some interesting comments upon the military wagons, perhaps one of the most important portions of the subject.

Three of the army wagons which entered the trials received awards and were purchased by the War Department: the Delahaye, the de Dion-Bouton, and the Gillet-Forest machines. It is a matter of especial interest that two of these vehicles, the Delahaye and the Gillet-Forest, were distinctly different in design from the accepted type of pleasure vehicle. As M. Dantin well remarks, it is a very encouraging thing to see a recognition of the fact that something more is necessary than to put an ordinary wagon body upon the chassis of a pleasure vehicle. The conditions of ordinary industrial service demand especial attention in connection with the proper design of delivery wagons and similar vehicles, and this is even more true in connection with the design of wagons for the necessarily severe requirements of military service.

For military service the question of tires is of great importance. In some of the army wagons entered in the trials the tires were excessively heavy, more so than the service warranted. But one of the military vehicles was provided with pneumatic tires, and it is the general opinion of military men that these are unsuited for army service. Iron tires were used on some of the machines, but their use did not appear to benefit the mechanism, while the wheels themselves showed traces of fatigue after the comparatively short run.

In the opinion of M. Dantin the military automobiles were given a higher speed than is necessary in actual service. Instead of 20 to 25 kilometres per hour, a speed of 15 kilometres is sufficient for army wagons, and reliability and efficiency are the essentials rather than speed.

On the whole it is most satisfactory to perceive that some attention is being paid to industrial automobiles, and that high-speed pleasure vehicles are not considered the only thing. It has long been a stock argument of the racing enthusiast that the development of the high-powered high-speed automobile would be of great benefit to the designers of industrial vehicles. This is true, however, to but a limited extent, and the elements which constitute a satisfactory business or military wagon must be largely worked out in accordance with the actual requirements, and not from race track experience. Much valuable information will doubtless be gained from such trials as those which have just been conducted by the Automobile Club, and these may now well be supplemented by the putting of the successful vehicles into actual service. Questions of wear and tear, of rough usage at the hands of ignorant and careless drivers and loaders, and all the innumerable tests of working service, will reveal points for improvement and reinforcement, and it is out of such experience that the wholly satisfactory industrial automobile will be perfected.

STEAM TURBINE CLASSIFICATION.

A REVIEW OF VARIOUS FORMS OF STEAM TURBINES WITH RESPECT TO THE MANNER OF ACTION OF THE STEAM.

Storm Bull—Western Society of Engineers.

IN considering the steam turbine as a prime mover it is not uncommon to regard it in somewhat the same category as the hydraulic turbine, and for some reasons such a classification is natural. This feature is well brought out in a paper recently presented before the Western Society of Engineers by Professor Storm Bull, and some abstract of his views may be here reviewed as aiding to give a clearer understanding of this group of machines.

"As there seems to exist a great deal of confusion in the minds of many engineers as to the essential differences between the various turbines, an attempt will here be made to give a classification, based on the manner in which the steam acts in the several wheels. Such a classification should not be based on external appearances, nor on speed, but only on the essential different ways in which the energy of the steam is utilized in the various turbines. The real difference between a steam engine and a steam turbine, is that, in the first named the pressure or tension of the steam is utilized directly, whereas in the latter the energy of the steam—as measured by the pressure and temperature—is first changed into kinetic energy, and it is only after this has occurred that the turbine wheel is ready to absorb it.

"The parallelism between the water and steam turbines is, therefore, complete, and the only essential difference between the two is that in the latter the acting fluid—steam—is compressible, whereas for all practical purposes in this connection, water may be assumed to be non-compressible. But, notwithstanding this difference, it seems but rational to use the same classification for both, although, as will be seen later, the fact that the steam turbine uses a compressible fluid, makes possible a very much larger variety of turbines than is possible in water turbines. As you probably all know, these latter are classified according to whether the water, when it comes to the turbine wheel, is under atmospheric pressure or under a high pressure; or to put it a little differently, whether the velocity of the water at the entrance to the turbine wheel is that due to the full head at that place, or whether the velocity is smaller than that. The turbines belonging to the first named class, have been named 'impulse turbines,' the latter, 'reaction turbines,' and the same definitions may be used for classifying steam turbines, changing the word head to pressure, and the atmospheric pressure to pressure of condenser. There would, consequently, be two classes of steam turbines, according to whether the energy of the steam, when reaching the turbine wheel, had been all changed into a kinetic form, or, if only partially so, the first class being named impulse wheels and the second one reaction wheels. These are, as everybody will see, very inappropriate, as there is no turbine wheel, whether utilizing the energy of falling water, or of expanding steam, that does not utilize the reaction of the flowing fluid, and that, consequently, all turbine wheels are reaction wheels. It would, therefore, seem to be quite rational to introduce new names for these two classes; at least for the steam turbine. The name of a class should be indicative of the essential characteristic of the class, and as a consequence, I propose as names for these classes—in harmony with one of the highest authorities of Germany, Mr. Wm. Gentsch—those of velocity turbines and pressure turbines, so that, for instance, the de Laval turbine would be a velocity turbine, and the Parsons, a pressure turbine."

The classification of steam turbines is complicated somewhat by the fact that it is possible with steam to introduce the so-called multi-stage turbine, and thus enable the velocity to be reduced. This enables the speed to be reduced in several stages and thus avoid some of the constructive difficulties inseparably connected with high rotative speeds.

The Rateau turbine, which has already been fully described in these pages, is classified by Professor Bull as a velocity turbine, although it is sometimes placed among the pressure turbines. Here the space between each wheel forms a reservoir, from which the steam flows into the next guide wheel, the expansion taking place in the guide wheels, except so far as it is necessary to overcome the resistance in the turbine wheels.

In many stage pressure turbines, the pressure is gradually reduced from the moment the steam enters the first guide wheel until it enters the condenser. The expansion of the steam takes place both in the guide and turbine wheels, the velocity of the steam also increasing, and more rapidly, toward the end than to begin with. The most prominent example of the class of steam turbines is that of Parsons' which is now being built in large numbers, and up to 10,000 K. W., in nearly all of the large industrial centers of the world. Depending on the pressure of the steam and of the power of the turbine, the number of wheels in a Parsons turbine may be as large as 80, although about 60 probably is more nearly the average. It is of course quite possible to build a Parsons turbine with a very much smaller number of wheels, and evidently such a turbine would be very much cheaper to build. The drop of pressure would then be correspondingly greater for each wheel, also the velocity of the steam as well as that of rotation, and consequently the number of revolutions. If, therefore, it be desired to design a wheel with a comparable low number of revolutions, it is necessary to use a large number of wheels, and presumably this consideration has been the leading one at least in the choice of the number of wheels in the Parsons wheel as it is built. Questions of the strength of materials necessarily also enter the problem, and to a certain extent also the efficiency of the turbine. With a high velocity of the steam, the friction per running foot necessarily must be greater than for a low velocity, as it is supposed to vary with the square of the velocity; but at the same time the length of the path along which the steam must flow is being reduced by increasing the pressure drop, so that the question, when the friction is the smallest, is not an easy one to solve.

The question of vacuum in the operation of steam turbines is discussed by Professor Bull in a very clear and interesting manner.

"A steam turbine can, of course, be run non-condensing, and its efficiency, if designed for this purpose, is probably as good as that of the non-condensing engine. But it is a fact, which is established by a large number of tests, that it is very much more important to have a good vacuum for a steam turbine than for a reciprocating engine, because the gain in economy is very much greater. It is therefore not unusual to hear of 28-in. vacuum for a steam turbine, and such high vacuum has only become possible by the introduction of new and improved condensers and air pumps, which owe their origin to the demands of the designers of the steam turbines. Why the gain in economy, because of a high vacuum, should be so much higher for the steam turbine than for the ordinary steam engine, is a question which has troubled a great many persons. The answer is, however, quite simple. Because of the increased condensation, it has been found unprofitable to extend the expansion down to the back pressure line in the steam engine, so that the steam, when exhausted, possesses a considerable amount of energy over and above that at the pressure of the condenser, which energy consequently is lost. In the turbine this is entirely different, as the condensation is so small that it does not need to be taken into consideration, and the energy of the steam is changed into a kinetic form, and which, in amount, is proportional to the difference in pressure between that of admission and of condenser. This energy can be utilized, except for friction losses—down to a certain minimum, corresponding to the necessary velocity of the steam when it leaves the last wheel, and which is the same, whether the vacuum is high or low. Although, therefore, there is gain in economy for the steam engine by increasing the vacuum, yet it cannot be so great as for the steam turbine, because the losses of condensation increase so much more rapidly than in the case of the turbine. It need hardly be stated here that too much money may be paid in order to get a high vacuum; the extra expense may more than outweigh the gain in steam consumption."

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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BRIDGES.

Arch.

The Plauen Viaduct. Illustrated description of this viaduct in Saxony which comprises the largest arch masonry ring in the world. 2000 w. Sci. Am Sup—Sept. 16, 1905. No. 71904.

Bascule.

Bascule Bridge over the Oder River, at Stettin (Pont à Basculement sur l' Oder, à Stettin). A Bidault des Chaumes. Well illustrated description of rolling-lift bridge in northern Germany. 1 Plate. 1500 w. Génie Civ—Aug. 19, 1905. No. 72134 D.

Brooklyn Bridge.

The Extension of the Manhattan Terminal of the New York and Brooklyn Bridge. General remarks on the many great engineering works in progress, to improve the terminal facilities of the transportation lines of New York City, and especially discussing the plans proposed for improving the terminal named. Ills. 2500 w. Archts & Builds Mag—Sept. 1905. No. 71684 C.

Budapest.

The Elizabeth Bridge at Budapest. Illustrated description of a handsome bridge almost identical with the "eyebar" design proposed for the new East River bridge at New York. Editorial. 2500 w. Sci Am—Sept. 9, 1905. No. 71837.

Floors.

Waterproofing Bridge Floors. A review of the tests reported in a paper by W. C. Cushing, read before the Am. Ry. Engng. & Main. of Way Assn. 3000 w. Engng—Sept. 1, 1905. No. 71784 A.

Foot-Bridge.

The Ginn Field Foot-Bridge, Boston Metropolitan Park System. William T. Pierce. Illustrated description of a small wooden foot-bridge of pleasing design. 3000 w. Eng News—Sept. 14, 1905. No. 72047.

New York City.

Report of Commissioner of Bridges of New York City. Data, principally in regard to the East River bridges, taken from the very interesting report of Bridge Commissioner George E. Best. 2700 w. R R Gaz—Vol. XXXIX. No. 10. No. 71859.

Plate Girder.

A Long Single-Track Plate-Girder Span. Illustrated and describes a single-track deck span on the Mahoning Division of the Erie R. R., with two plate girders 131 ft. 4 in. long, 9 ft. apart on centers, which carry a track with a curvature of 3 degrees 30 minutes, its construction and erection. 2000 w. Eng Rec—Sept. 16, 1905. No. 71971.

Quebec.

Progress on the Quebec Bridge. Gives recent photographs and data of the progress made in the construction of this bridge across the St. Lawrence River. 3500 w. Eng Rec—Sept. 16, 1905. No. 71968.

The 1800 Ft. Span Cantilever Bridge Across the St. Lawrence River at Quebec. An illustrated article giving interesting information regarding the cantilever portion of the structure. 1000 w. Eng News—Sept. 14, 1905. No. 72050.

The St. Lawrence River Bridge at Quebec, Canada. Illustrated description of a bridge designed to carry two lines of railroad, two trolley lines, two highways and two sidewalks. 900 w. R R Gaz —Vol. XXXIX. No. 11. No. 71913.

Reinforced Concrete.

A Reinforced Concrete Double-Track Railroad Arch Bridge. Drawings and description of a bridge being constructed near Vulcanite, N. J., to carry two main line tracks of the Central R. R. of N. J. over a highway. 1500 w. Eng Rec—Sept. 9, 1905. No. 71897.

Reinforced Concrete Ribbed Arch Bridge at Deer Park Gorge. J. B. Strauss. Illustrated description of an interesting foot-bridge and the methods of erection. The advantages of the ribbed bridge are said to be its economy, adjustability of the structure under settlement, and accessibility for inspection. 1600 w. Eng News—Sept. 21, 1905. No. 72053.

Thebes.

The Erection of the Thebes Bridge Superstructure. Illustrated detailed description of the methods used in erecting the double-track railroad bridge over the Mississippi River at Thebes, Ill. 2000 w. Eng Rec—Sept. 16, 1905. No. 71974.

Transporter.

The Widnes-Runcorn Transporter Bridge. Illustrated detailed description of this bridge on the river Mersey, and its electrical working. 2700 w. Tram & Ry Wld—Sept. 14, 1905. No. 72088 B.

An Electric Aerial Ferry. Frank C. Perkins. Illustrated description of a type of bridge in operation across the Duluth Ship Canal. Electric motors furnish the power for the ferry car. 1200 w. Elec N Y—Aug. 30, 1905. No. 71976.

Viaduct.

Concrete Viaduct at Riverside, California. H. Hangood. An illustrated detailed description of an important structure over the Santa Ana River. It has a total length of 984 feet, and an average height of 55 feet. 3500 w. Eng Rec—Sept. 9, 1905. No. 71894.

CONSTRUCTION.

Building Collapse.

The Collapse of a Department Store Building at Albany, N. Y. Gives a summary of the circumstances of the accident, which occurred during reconstruction work. Also editorial. Ills. 5000 w. Eng News—Sept. 7, 1905. No. 72044.

The Collapse of the Meyers' Building, Albany. Explains the conditions existing, and the cause of the disaster, giving extracts from the report made by the committee of examination. 1300 w. Eng Rec—Sept. 2, 1905. No. 71890.

Caissons.

A Peculiar Pneumatic Caisson Wreck. Describes an accident on the foundation work of the new United States Express Co. building on Greenwich st., New York. Ills. 1000 w. Eng Rec—Sept. 16, 1905. No. 71970.

Chicago Tunneling.

Settlement of Chicago Buildings Due to Tunneling. From the supplement to the report of the commission giving a detailed statement of places where the settlement of streets and buildings can be attributed to this work. 1800 w. Eng Rec—Sept. 23, 1905. No. 72224.

Cistern.

A 75,000 Gallon Concrete Steel Cistern. Edward Godfrey. Illustrated description of a cistern, to be used for fire protection, built at Allegheny, Pa. 1200 w. Eng News—Sept. 28, 1905. No. 72283.

Coffer-Dams.

Steel Coffer-Dams in the Chicago River. E. James Fucik. Describes the conditions found in the Chicago River and the use of a steel sheeting for cofferdams, describing in detail the two types used. Ills. 1800 w. Technograph No. 19, 1904-1905. No. 72266 D.

Concrete Plant.

Concrete Plant for the Brooklyn Anchorage of the Manhattan Bridge. An illustrated account of the concrete machinery and special plant which has been installed at a great cost with the aim of executing the work with the greatest economy and rapidity. 2500 w. Eng Rec—Sept. 9, 1905. No. 71896.

Dams.

Dams for the New Plant of the United Shoe Machinery Co., Beverly, Mass. Describes the construction of two concrete and one earth dam. 3000 w. Eng Rec—Sept. 2, 1905. No. 71893.

Earth Dams with Concrete Core Walls. Clemens Herschel. Gives the writer's views and methods on this subject as expressed in a discussion, with a history of, and justification of this form of construction. 2800 w. Eng News—Sept. 7. 1905. No. 72043.

Movable Dam and Lock of the Rice Irrigation and Improvement Association, Mermentau River, La. Illustrates and describes work carried out to effectually shut out the salt water, which injured the rice crops, and for preventing overflow of the adjacent low lands. 600 w. Eng News—Sept. 28, 1905. No. 72280.

The Scioto River Storage Dam at Columbus, Ohio. John H. Gregory. An explanation of conditions at Columbus, and the need of additional supply, describing the dam and reservoir which are now under construction. Ills. 4000 w. Eng Rec—Sept. 9, 1905. No. 71899.

The Determination of Pressures on Masonry Dams (Zur Ermittlung von Kantenpressungen bei Sperrmauern). F. Stupecky. Diagrams and discussion of formulæ and methods. 1500 w. Oest Wochenschr f d Oeff Baudienst—Aug. 19, 1905. No. 72111 D.

Engine Foundations.

Cement Mortar Blocks and Engine Foundations. Paul J. Johnson. Gives some practical results with suggestions. 2000 w. Min Rept—Sept. 21, 1905. No. 72237.

Excavator.

A Submarine Rock Excavator. From a paper by G. C. Hepburn, published by the Inst. of Civ. Engrs. Illustrated description of a drilling apparatus used in Australian harbor improvements. 1000 w. Eng Rec—Sept. 16, 1905. No. 71972.

Fireproof Buildings.

Fireproof Construction the Only Method of Reducing the Nations Enormous Fire Loss. Alcide Chausee. Read before the Am. Soc. of Munic. Imps. Gives statistics of losses by fire, urging the importance of strict building regulations. 1800 w. Eng News—Sept. 21, 1905. No. 72055.

Foundations.

Chicago Foundations. E. C. Shankland. Briefly considers the evolution from the old spread or floating foundation to the present use of concrete caissons. 3300 w. Technograph—No. 19, 1904-1905. No. 72261 D.

Foundations on Muddy Ground (La Fondation des Ouvrages en Terrains Vaseux). Lt. Col. G. Espitallier. Abstract of article by Col. Petitbon in the *Revue de Génie,* on difficult foundation work at Saigon, French Indo-China. 2200 w. Génie Civ—Sept. 15, 1905. No. 72142 D.

Framework.

The Theory of Framework with Rectangular Panels, and Its Application to Buildings which Have to Resist Wind. Ernst F. Jonson. Develops the exact theory of frameworks with rectangular panels, and suggests methods that may be of use in actual designing. Mathematical. 1800 w. Pro Am Soc of Civ Engrs—Sept. 1905. No. 72291 E.

I-Beams.

I-Beam Buckstays. J. H. Granbery. Shows the advantage in cost and strength gained by the use of buckstays of I-beam and channel sections in place of the tee-rail. 600 w. Eng & Min Jour—Sept. 16, 1905. No. 71931.

Lighthouse.

Construction of the Beachy Head Lighthouse, England (Construction du Phare de Beachy Head, Angleterre). Illustrated description of lighthouse built 700 feet off shore, and of cableway used in its construction. 1 Plate. 1500 w. Génie Civ—Aug. 26, 1905. No. 72136 D.

Reinforced Concrete.

A Unit Frame Reinforcement System of Concrete Steel Construction. Illustrates and describes a unit frame reinforcement for concrete girder and floor construction. 1200 w. Eng News—Aug. 31, 1905. No. 72027.

New Design for Armored Concrete Tunnels. Illustrates and describes a design in which there is no protective lining, and thin steel plates and channels are adopted to afford a built-up ring. 1400 w. Engr Lond—Sept. 15, 1905. No. 72062 A.

The New Reinforced-Concrete Shops and Car Houses of the Central Pennsylvania Traction Company, at Harrisburg, Pa. Mason D. Pratt. Well illustrated description. Reinforced concrete is used throughout. 2000 w. St. Ry Jour—Sept. 2, 1905. No. 71729 C.

The Pugh Power Building, in Cincinnati, O., constructed of Reinforced Concrete (The Pugh Power Building, ein Hohes Gebäude aus Eisenbeton in Cincinnati, O.). Illustrated description. 1 Plate. 700 w. Beton u Eisen—No. 9, Sept., 1905. No. 72127 F+H.

A Reinforced-Concrete Coal Pocket, Atlantic City Water Works. Kenneth Allen. Illustrates and describes a recently completed coal pocket of unique form, and the method of construction. 1200 w. Eng Rec—Sept. 16, 1905. No. 72056.

Reservoirs.

Method and Cost of Concreting Jerome Park Reservoir, New York City. Halbert P. Gillette. Illustrates and describes the work of lining 250 acres of reservoir basins with concrete, discussing the economics and suggesting improvements. 1800 w. Eng News—Sept. 21, 1905. No. 72056.

Ancient Reservoirs of Carthage. Brief illustrated description of these remarkable structures. 700 w. Sci Am—Sept. 23, 1905. No. 72206.

Roof Shield.

The New Roof Shield for the Metropolitan Railway Tunnel of Paris. R. Bonnin. Explains the lack of success of the half section shield, which was to have been used for this work, and illustrates and describes the new type and its operation. 4800. Eng News—Sept. 28, 1905. No. 72281.

Simplon Tunnel.

Simplon Tunnel (Simplon-Tunnel), Abstract of report on the progress of work to the end of June, 1905. Tables. 1000 w. Schweiz Bauzeitung—Aug. 25, 1905. No. 72118 D.

Standpipe.

A Large Reinforced Concrete Standpipe. George W. Blodgett. Describes a standpipe 110 ft. high and 50 ft. in diameter built in the town of Attleboro, Mass. 1000 w. R. R. Gaz—Vol XXXIX. No. 11. No. 71919.

Steelwork.

Steelwork of the Wanamaker Building, Philadelphia. Begins an illustrated description of the steelwork in one of the largest department stores ever erected. 2000 w. Eng. Rec. Sept. 2, 1905. Serial. 1st part. No. 71892.

Steel Structural Work for Railway Stations and Workshops (Die Lütticher Weltausstellung. Eisen Konstruktionen für Bahnhöfe und Werkstätten). Bruno Schwarze. Illustrated descriptions of roofs, cranes, etc., of railway shops and stations. 1200 w. Glasers Annalen—Sept. 15, 1905. No. 72126 D.

Tunnels.

The Pennsylvania R. R. Tunnel Under Capitol Hill, Washington, D. C. An illustrated article giving details of the methods of excavation and the machinery employed in this example of soft ground tunneling. 2800 w. Eng News—Sept. 14, 1905. No. 72049.

Progress on the Battery Tunnel, New York. An illustrated report of the progress made and methods adopted in the construction of this interesting work. 1200 w. Eng Rec—Sept. 9, 1905. No. 71898.

MATERIALS OF CONSTRUCTION.

Brick.

Tests of Sand-Lime Brick. L. E. Curfman. Gives a report of tests made by the writer and the results. 3500 w. Technograph—No. 19, 1904-1905. No. 72265 D.

The Manufacture of Sand-Lime Brick. Illustrated description of a manufacturing plant and its operation. 1300 w. Eng News—Aug. 31, 1905. No. 72023.

The Evolution of the Babylonian Brick. Prof. Edgar James Banks. An account of the history as shown by the interesting discoveries made at Bismya, in Central Babylonia. Ills. 1200 w. Eng News —Sept. 7 1905. No. 72046.

Cement.

Cement and Concrete Tests at the St. Louis Exposition. Richard L. Humphrey. Gives a description of the results of the tests which were made. 4000 w. Eng News—Sept. 21, 1905. No. 72057.

Changes Which Take Place in the Clinkering of the Lehigh Valley "Cement Rock." Richard K. Meade. Read before the Assn. of Portland Cement Mfrs. A report of experimental investigations. discussing results. 2000 w. Cement—Sept. 1905. No. 72284 C.

The Chemical Analysis of Limes and Cements. M. J. Malette. Remarks on the advantages and need of agreement in the methods of testing such materials, giving a method considered as giving a very satisfactory guarantee of exactitude. 2000 w. Builder—Sept. 2, 1905. No. 71666 A.

Concrete.

A System of Safeguards Against Freezing in Concrete Building Construction. Illustrates and describes the means adopted to prevent damage by frost in constructing the shops of the Foster-Armstrong Piano Co., at Rochester, N. Y., which proved entirely successful. Also editorial. 2500 w. Eng. News. Sept. 7, 1905. No. 72040.

Notes on Concrete. C. E. P. Sankey. On specifications for concrete, discussing the percentage of voids, quality and quantity of mortar and other ingredients, and methods of determining them, the making of concrete, etc. 2000 w. Engng—Sept. 1, 1905. No. 71778 A.

Concrete Blocks.

The Manufacture and Use of Concrete Blocks. F. W. Hagloch. Considers the selection of material, proportioning and curing of concrete blocks. 3000 w. Eng News—Aug. 31, 1905. No. 72028.

Hollow Concrete Block Building Construction. S. B. Newberry. Discusses these blocks as a building material, their manufacture, properties, cost, etc., giving two designs illustrating their use. 2200 w. Cement—Sept., 1905. No. 72285 C.

Non-Metallic Materials.

Specific Gravity and Weight of Building Stone, Cements, and Other Non-Metallic Structural Materials. Edwin C. Eckel. Aims to give reliable data on the specific gravity and weight per cubic foot of various classes of building stones, and also of plasters, limes, and cements. 2000 w. Eng News—Sept. 7, 1905. No. 72039.

Reinforced Concrete.

Consistency in the Reinforcement of Concrete. Louis F. Brayton. Discusses the use of this material and the important things to be considered in the designs submitted. 6000 w. Technograph—No. 19, 1904-1905. No. 72262 D.

Comment on the Advantages and Limitations of Reinforced Concrete. Charles S. Hill. Read before the Assn. of Portland Cement Mfrs. Deals with the principle of reinforced concrete; its claims as a structural material; the qualities of design and workmanship; and the evils attending it. 2000 w. Min Rept—Sept. 14, 1905. No. 71923.

Graphical Calculation of the Moment of Resistance of Reinforced-Concrete Plates and Plate Girders (Graphische Berechnung des Widerstandsmomentes von Eisenbeton-Platten und Plattenbalken). P. Weiske. Mathematical discussion. 1000 w. Beton u Eisen—No. 9, Sept., 1905. No. 72128 F+H.

International Association for Testing Materials (Association Internationale pour l'Etude et l'Essai des Matériaux). Note by M. Maynard on changes of volume of cement when subjected to moisture and immersed in water, and on reinforced-concrete tests and phenomena. Diagrams and curves. 3000 w. Rev. Tech—June 10, 1905. No. 72146 D.

See also Civil Engineering, Construction.

Roofing.

Terne Plates for Tin Roofing. William Martin. Read before the Nat. Assn. of Master Steel Metal Workers. Discusses the causes of the decadence of terne plates as a roof covering. Also discussion. 3500 w. Am. Arch—Sept. 2, 1905. No. 71683.

MEASUREMENT.

River Profile.

River Profile Work of the United States Geological Survey, Kennebec River, Maine. Arthur D. Butterfield. Describes work carried out in Maine, and confined to the part of the Kennebec River extending from the top of the dam at Showhegan to the highway bridge at The Forks. Describes methods and work giving general results. 3500 w. Eng News—Aug. 31, 1905. No. 72024.

Simplon Tunnel.

The Final Results of the Measurements of the Simplon Tunnel (Die Schlussergebnisse der Absteckung des Simplontunnels). Prof. M. Rosenmund. Discussion of the small errors in direction and level found after the tunnel had been finished. 2400 w. Schweiz Bauzeitung—Sept. 9, 1905. No. 72120 D.

MUNICIPAL.

Cesspool.

The Knobloch Cesspool (Die Knobloch'sche Senkgrube). Prof. O. Richter. Illustrated description of a biological chemical process for purifying cesspool contents. 1 Plate. 1500 w. Oest Wochenschr f d Oeff Baudienst—Aug. 26, 1905. No. 72113 D.

Columbus, O.

Progress on the Sewage Works and Water Softening and Purification Works of Columbus, Ohio. Julian Griggs. Abstract of a paper presented before a gathering of municipal organizations, giving information of the progress made on these improvements. 1400 w. Eng News—Sept. 21, 1905. No. 72058.

Feldsberg.

Water Supply and Sewage of the Town of Feldsberg, Lower Austria (Trinkwasserleitung und Kanalisation der Stadtgemeinde Feldsberg, N. Oe.). Franz Florian. Description of waterworks, mains, sewers, etc., of a small town, with illustrations and plans. 4 Plates. 4500 w. Oest Wochenschr f d Oeff Baudienst —Sept. 9, 1905. No. 72114 D.

Incinerating Plant.

Electric Light and Rubbish in New York City. S. S. Edmonds. Describes the new combined rubbish incinerator and electric lighting plant at Delancey Slip, Manhattan. Ills. 3000 w. Engr, U S A—Sept. 1, 1905. No. 71848 C.

London.

The Traffic of London. George S. C. Swinton. Reviews the report of the Royal Commission, appointed to inquire into the means of locomotion and transport in London. 7500 w. Nineteenth Cent —Sept., 1905. No. 71953 D.

Oiled Roads.

The Use of Oil on Macadam Roads and Oil-Asphalt Streets in California. Theodore F. White. Reviews the methods and results obtained by the use of oil, and the construction of asphalted-macadam roads. 1500 w. Eng News—Sept. 21, 1905. No. 72059.

Pavements.

Factors in Asphalt Paving Construction, Maintenance and Cost. Andrew Rosewater. Interesting statements in regard to the increase of this pavement, the cost, wearing capacity, construction, materials, maintenance, etc. 5000 w. Munic Engng—Sept., 1905. No. 71944 C.

Road Curves.

Radius and Width of Curves in Roads (Krümmungshalbmesser und Breite der Strassenwendeplätze). Prof. F. Loewe. Discussion of the layout of curves in streets and roads, with formulæ and diagrams. 3000 w. Zeitschr d Oest Ing u. Arch Ver—Aug. 25, 1905. No. 72166 D.

Sewage.

Sewage and Its Disposal. H. Lemmoin-Cannon, in *Technics*. Considers some of the principal methods used for its treatment and disposal. 3000 w. Sci Am Sup —Sept. 23, 1905. No. 72208.

Sewers.

Rainfall and Run off in Sewer Design. Charles Emerson Gregory. Extracts from a lecture before the Engng. School of Union College, Schnectady, N. Y., and a discussion before the Am. Soc. of Civ. Engrs., giving the latest advances in this subject. 4500 w. Munic Engng—Sept., 1905. No. 71942 C.

Smoke.

Municipal Control of Smoke. R. P. King. Condensed paper read before the League of Am. Municipalities. A review of municipal smoke prevention, with many suggestions of value. 2800 w. Eng News —Aug. 31, 1905. No. 72026.

Street Repairs.

The Organization and conduct of the Brooklyn Bureau of Street Repairs. Edwin J. Fort. Read before the Am. Soc. of Munic. Imp. Explains the organization under which the work in Brooklyn has been successfully carried on. 4000 w. Eng News—Sept. 28, 1905. No. 72279.

Tar Macadam.

Notes on Trials of Coal Tar Pavements at Saint Nazaire-sur-Loire, in 1904-1905. (Note sur les Essais de Goudronnage Executés à Saint-Nazaire-sur-Loire en 1904-1905). D. Guillou. Account of experience with tar macadam pavement. 1500 w. Rev Tech—June 10, 1905. No. 72145 D.

WATER SUPPLY.

Conduits.

The Most Economic Type of Hydraulic Power Conduits. Fred C. Frinkle. Address before the Twelfth Irrigation Congress. Describes the concrete and cement pipe now used in California, and the method of construction. 1500 w. Eng Rec—Sept. 2, 1905. No. 71888.

Coolgardie.

Water Supply for Coolgardie, Australia (Alimentation de Coolgardie en Eau Potable par une Conduite de 565 Kilomètres). Paul Raulin. Description, with plans and illustrations of steel pipe line 350 miles long, and 30 inches in diameter. 2000 w. Génie Civ—Aug. 26, 1905. No. 72137 D.

Edinburgh.

The Talla Water-Works. Illustrates and describes this recent addition to the Edinburgh water supply, giving information in regard to the work and its cost. 1400 w. Engr Lond—Sept. 1, 1905. No. 72009 A.

Fire Protection.

High Pressure Systems for City Fire Protection. Albert Blauvelt. A discussion of fire protection in the large cities of America. 5000 w. Cassier's Mag—Sept., 1905. No. 72257 B.

Fire Department Water Supply. Charles A. Hague. Read before the League of Am. Municipalities, at Toledo, O. A comprehensive review of requirements and methods. 7500 w. Munic Jour & Engr—Sept., 1905. No. 71689 C.

City Water-works Systems. E. G. Hopson. Discusses the water pressures of the domestic supply systems from the fire protection point of view. 6000 w. Ins Engng—Sept., 1905. No. 72250 C.

Flumes.

Reconstructing the Flumes on the Turlock Irrigating Canal. H. A. Crafts. Describes the permanent construction to take the place of the wooden flumes, which are already in serious decay. Ills. 1000 w. Eng Rec—Sept. 2, 1905. No. 71889.

Irrigation.

Address by Colonel Sir C. Scott Moncrieff before the British Association. Address before the engineering section, on the science of irrigation, describing what has been accomplished in various parts of the earth. 8500 w. Nature—Sept. 7, 1905. No. 71955 A.

On the Cost of Irrigation by Electrically Driven Pumps from Transmission Services. W. W. Wheeler. Read before the Pacific Coast Engng. Cong. Gives the writer's experience in Northern California. 2500 w. Jour of Elec—Sept. 1905. No. 72098 C.

The Truckee-Carson Irrigation Project. Herbert I. Bennett. An illustrated article explaining the purpose of this canal, and describing the work. 2000 w. Sci Am —Sept. 16, 1905. No. 71900.

The Truckee-Carson Reclamation Project. Enos Brown. Illustrated description of this great irrigation project undertaken by the government. 1700 w. Sci Am Sup—Sept. 16, 1905. No. 71903.

Time Test of a Great Irrigating System. H. A. Crafts. Brief illustrated description of the Turlock and Modesta irrigating systems, in California. 900 w. Sci Am—Sept. 2, 1905. No. 71831.

Pumping Station.

The New Lardner's Point Pumping Station, Philadelphia. Illustrated detailed description of the buildings, boilers, flues and chimneys, coal supply, piping system, pumping engines, conduits, etc. 4000 w. Eng Rec—Sept. 16, 1905. No. 71969.

Sterilization.

Sterilization of Water. Emile Guarini. Illustrated description of the De Frise ozonizing plant and its working. 1700 w. Sci Am—Sept. 2, 1905. No. 71834.

Water Pipes.

Cost of Laying Water Pipe, Atlantic City, N. J. Kenneth Allen. Gives cost figures for about three miles of 12 to 4-in. pipe. 500 w. Eng News—Sept. 14, 1905. No. 72051.

WATERWAYS AND HARBORS.

Antwerp.

The Port of Antwerp. Reviews briefly the development of this port to keep pace with the increase of commerce, and the scheme for the construction of new docks. Plans. 2000 w. Builder—Sept. 2, 1905. No. 71665 A.

Enlargement of the Port of Antwerp. Information concerning the plan adopted for the vast extension which will triple the area of the port, giving it 60 kilometers (37.3 miles) of running quays. 1600 w. U S Cons Repts—June, 1905. No. 72019 D.

Bank Protection.

The Use of Cobblestones Imbedded in Portland Cement in River Improvements (Die Anwendung von mit Portlandzement Gebundenen Klaubsteinen bei Flussregulierungen). Max Jesovits. Illustrated methods of protecting river banks. 400 w. Oest Wochenschr f d Oeff Baudienst—Sept. 9, 1905. No. 72115 D.

Canal Lifts.

Means for Overcoming Great Differences in Level by Vessels in Internal Waterways (Moyens de Faire Franchir les Grands Chutes par les Bateaux de Navigation Intérieure). A. de Bovet. Review of results of the recent Austrian competition for canal lifts, locks, inclined planes, etc. 6500 w. Mem Soc Ing Civils de France—Aug., 1905. No. 72184 G.

Preliminary Work on the Panama Canal. John F. Wallace. The second of a series of articles, which shows the physical and governmental red-tape difficulties encountered, and the necessary preparation and organization before work on the canal begins. 5000 w. Eng Mag—October, 1905. No. 71701 B.

See also Industrial Engineering.

Dredges.

Dredges (Les Dragues). A Baril. A general review, with illustrations of various types of river and seagoing dredges and their parts, partly taken from *Engineering*. 4000 w. Rev. de Mécanique—Aug. 31, 1905. No. 72185 E+F.

New Sea-Going Dredges. Day Allen Willey. Illustrates and describes the dredges used in improving the ship channel leading into New York harbor. 1200 w. Sci Am Sup—Sept. 2, 1905. No. 71835.

Evolution of the California Clam-Shell Dredger. H. A. Crafts. Illustrations, with remarks on the recent improvements in this type of dredger, which is especially adapted to river and reclamation work. 700 w. Sci Am—Sept. 30, 1905. No. 72288.

Hydraulic Suction Dredge on the Mississippi. Day Allen Willey. Illustrations showing the arrangement of the pumping and other machinery on the dredge "Beta," with description and account of service. 1000 w. Sci Am—Sept. 23, 1905. No. 72205.

Genoa.

The Development of the Harbor Works of Genoa (Die Bauliche Entwicklung des Hafens von Genua). E. Bavier. General historical account. Serial. Part 1. 2000 w. Schweiz Bauzeitung—Aug. 19, 1905. No. 72116 D.

Niagara.

To Dam Niagara. Discusses briefly the scheme under consideration of the International Waterways Commission for raising the level of Lake Erie by putting a dam across its outlet in the Niagara River. 1300 w. Engr Lond—Aug. 25, 1905. No. 71798 A.

Nile.

Some Problems of the Upper Nile. Sir William E. Garstin. An account of the schemes proposed for controlling the river, giving a brief description of the stream and its characteristics, and discussing the irrigation requirements of Egypt and the Soudan. 11500 w. Nineteenth Cent—Sept., 1905. No. 71952 D.

Philadelphia.

The Improvement of the Delaware River and Harbor and the Landing Facilities of the Port of Philadelphia. George S. Webster. A description of the work done by the city of Philadelphia in conjunction with the United States Government in the improvement of the channels of the Delaware and Schuylkill Rivers, and the landing facilities of the port by the widening of Delaware avenue, and the construction of more commodious piers. Maps and illustrations. 3800 w. Jour Fr Inst—Sept., 1905. No. 71981 D.

Seawall.

Galveston's Great Seawall. Brief illustrated description of this great engineering work. 1200 w. Marine Rev—Aug. 31, 1905. No. 71800.

United States.

Notes on the Improvement of River and Harbor Outlets in the United States. L. J. Le Conte and William W. Harts. Discussion of the paper by D. A. Watt, presented in *Proceedings* for May. 5200 w. Pro Am Soc of Civ Engrs—Sept., 1905. No. 72293 E.

MISCELLANY.

Executive Engineers.

The Executive Engineer. A lecture by Prof. White on the necessity of executive training for engineers who aspire to places of high honor. 3000 w. Technograph—Nov. 19, 1904-1905. No. 72264 D.

Florida Everglades.

The Florida Everglades: Their Legal Status, Their Drainage, Their Future Value. S. L. Lupfer. Describes these marshes, and discusses what has been done toward reclaiming them, and the legal causes of trouble. Map. 5000 w. Eng News—Sept. 14, 1905. No. 72052.

Legal Engineers.

The Legal Position of an Engineer. Gives a general view of an engineer's position and considers the form of agreement under which he may be employed. 3000 w. Engr Lond—Aug. 25, 1905. No. 71796 A.

Sanitation.

Sanitary Engineering in the South and the Labor Question. J. N. Hazlehurst. Read before the Am. Soc. of Munic. Imp. Describes the progress of sanitary work in the South, and some of the difficulties met in the construction of these works, giving information concerning the negro labor. 2000 w. Eng News—Sept. 21, 1905. No. 72054.

ELECTRICAL ENGINEERING

COMMUNICATION.

Faults.

Notes on the Localization of Cable Faults. Henry Joseph. The writer aims to investigate the conditions under which tests already published are likely to be useful, and to ascertain what steps should be taken to find the position of a fault, the nature of which is such that no test known to the writer can be applied with any degree of certainty. The conditions appertaining to a three-wire continuous current system with the neutral earthed at the station are particularly considered. 2500 w. Elec Rev Lond—Sept. 15, 1905. No. 72083 A.

Fire Alarm.

Suggested Improvements in Fire Alarm Telegraph Systems. William Brophy. Read before the Int. Assn. of Munic. Electn's. Suggests improvement in the circuits, showing the weakness of the present method of distribution. 5000 w. Fire & Water—Sept. 16, 1905. No. 71911.

Magini Telegraph.

An Important Innovation in Telegraphy. Editorial remarks on the recent invention of Signor Magini, and its importance in connection with telegraphy. Briefly describes this new system, which appears to employ high-frequency currents on an ordinary wire, the receiving apparatus containing a self-restoring coherer. 1000 w. Sci Am—Sept. 23, 1905. No. 72201.

Postal-Commercial Co.

The Development of the Postal Telegraph-Cable Company. Charles P. Bruch. General account of the Postal Telegraph and Commercial Cable companies, with map. 2000 w. Elec Rev N Y—Sept. 9, 1905. No. 71727.

Space Telegraphy.

"Wireless" Telegraphy. Sir Wm. H. Preece. Paper before the British Assoc., giving a general review. 5000 w. Elect'n Lond—Sept. 1, 1905. No. 71748 A.

Directed Wireless Telegraphy. Brief account of experiments made by Dr. Ferdinand Braun, at Strasburg. Also editorial. 1800 w. Elec Rev, N Y—Sept. 16, 1905. No. 72091.

Spark Gaps. James Foster King. Gives briefly a history of conditions existing in the spark gap in a space telegraph transmitter. 1300 w. Elec Wld & Engr—Sept. 23, 1905. No. 72217.

Submarine Cables.

Submarine Cables (Unterseekabel) Hermann Hildebrandt. Historical, descriptive and statistical with illustrations and tables. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1905. No. 72101 D.

Telegraph Current.

Weak current Plants Connected to Heavy-Current Systems (Ueber Schwachstrom-Lieferungsanlagen in Auschlusse an Starkstromnetze). Hans Carl Steidle. A discussion of the use of current from lighting and power systems, for telegraphy and telephony, particularly in connection with storage-batteries. Diagrams. 4000 w. Elektrotech Zeitschr—Aug. 24, 1905. No. 72149 B.

Telephone Exchange.

Multiple Switchboard System for the Telephone Exchange at Würzburg, Germany (Vielfach — Umschalteeinrichtung für die Fernsprechanlage zu Würzburg). J. Jacob. Illustrated description of a central-energy exchange and connections. 3500 w. Elektrotech Zeitschr—Aug. 31, 1905. No. 72154 B.

Telephone Lines.

Telephone Lines with High Inductance (Ueber Telephonleitungen Hoher Induktanz). Ludwig Kusminsky. Mathematical discussion. 1500 w. Oest Wochenschr f d Oeff Baudienst—Aug. 19, 1905. No. 72112 D.

Telephony.

Telephony. Herbert Laws Webb. An illustrated review of the history and development of the telephone. 7000 w. Jour Soc of Arts—Sept. 15, 1905. Serial. 1st part. No. 72065 A.

DISTRIBUTION.

Junction Boxes.

The value of Junction Boxes, with Cut-Out Switches, in Underground-Cable Networks (Ueber den Wert Ausschaltbarer Abzweigmuffen in Unterirdischen Kabelnetzen). C. Ankersen. Description and discussion of protected and accessible switches which can cut out sections of cable. 1200 w. Elektrotech Zeitschr—Sept. 14, 1905. No. 72160 B.

Mains.

Notes on Main's Work and Fault-Finding. G. C. Knight. Gives suggestions for the laying of mains, testing and fault-finding and earth finding and the calculations involved. 5000 w. Elec Rev Lond—Aug. 25 and Sept. 1, 1905. Serial. 2 parts. No. 71762 each A.

Mercury-Arc Rectifiers.

Mercury Arc Rectifiers. P. D. Wagoner. Abstract of paper before the Ohio Electric Light Assoc., giving an illustrated description of the commercial outfit of the General Electric Co., for charging vehicle storage batteries. 2000 w. Elec Rev, N Y—Sept. 2, 1905. No. 71721.

Rotary Converters.

Rotary Converters in Parallel with Storage Batteries (Umlaufende Einanker-Umformer in Parallelschaltung mit Pufferbatterien). B. Jacobi. Discussion of the use of rotary converters in connection with "floating" storage batteries on an electric distribution system, and particularly the arrangement on the electric railway at Remscheid, Germany. Diagrams. 1000 w. Elektrotech Zeitschr—Aug. 24, 1905. No. 72150 B.

See also Electrical Engineering, Generating Stations.

Starting Switch.

A new Automatic Starting Switch (Ein Neuer Selbstanlasser). Johannes Jessen. Illustrated description of automatic starting switch and resistances for electric motors. 2500 w. Elektrotech Zeitschr —Aug. 31, 1905. No. 72153 B.

Time-Limit Relays.

Time-Limit Relays. W. T. Fernandez. Discussion, with illustration and curve, of clock and bellows types of relays for automatically breaking electric circuits. 1500 w. Am Electr'n—Sept., 1905. No. 71741.

Wiring.

Wiring for Lamps and Motors—Meeting an Emergency. W. H. Wakeman. Describes the writer's plan of wiring and the changes made to meet an emergency. 900 w. Elec, N Y—Sept. 6, 1905. Serial. 1st part. No. 71978.

ELECTRO-CHEMISTRY.

Accumulators.

A Chat about Accumulators. S. R. Bottone. A consideration of the laws that govern the construction and action of a good accumulator. 1300 w. Elec Mag —Aug. 29, 1905. Serial. 1st part. No. 71979 A.

Acid Pickle.

Action of Acids on Iron and the Use of the Acid Pickle. Charles F. Burgess. Explains the term "pickle" as used in the metal-working industries, giving various applications, and describing the difference in practice prevailing among the users of the pickling operation. 4500 w. Elec Chem & Met Ind—Sept., 1905. No. 72093 C.

Castner Process.

The Castner Mercury Process for Producing Chlorine and Alkali (Das Quecksilberverfahren von Castner zur Gewinnung von Chlor und Alkali). M. Le Blanc. Laboratory experiments of Dr. Carlo Cantoni, at the Karlsruhe Technische Hochschule, with illustrations and tables. 1500 w. Zeitschr f Elektrochemie —Sept. 8, 1905. No. 72131 G.

Diamonds.

See Mining and Metallurgy, Miscellany.

Electrolysis.

Alternate-Current Electrolysis. Ernest Wilson. Abstract of paper before the Faraday Society, giving account of experiments with various metals and electrolytes, with table and curves. 2000 w. Elec'n, Lond—Sept. 8, 1905. No. 71753 A.

Alternate Current Electrolysis. Prof. Ernest Wilson. Read before the Faraday Society. An account of experiments made to determine what may be the effect upon certain metals of passing alternating currents between them and certain electrolytes under given conditions. 2800 w. Elec Engr, Lond—Sept. 15, 1905. No. 72081 A.

Gas Cell.

The Generator Gas Cell and the Carbon Cell (Das Generatorgas und das Kohlenelement). F. Haber and A. Moser. Description of laboratory experiments and results with gas batteries having the electrolyte of hot glass, and electrodes of carbon dioxide, carbonic oxide, oxygen and other gases. 7000 w. Zeitschr f Elektrochemie—Sept. 8, 1905. No. 72130 G.

Heroult Process.

The Heroult Process (Der Prozess Héroult). Illustrated description of electric furnace and process for the production of iron and steel. Serial. Part 1. 700 w. Elektrochem Zeitschr—Sept., 1905. No. 72133 G.

Nitrogen.

Utilization of Atmospheric Nitrogen (Utilisation de l'Azote Atmosphérique). A. Boileau. Description, with illustrations of electrical methods and apparatus for obtaining nitrogen and nitrogen compounds from the air. 4000 w. Génie Civ —Sept. 2, 1905. No. 72139 D.

Experiments on the Production of Oxides of Nitrogen by Means of High Voltage. Discharges in Air (Versuche über die Darstellung von Oxyden des Stickstoffs durch Hochspannungsentladungen in Luft). Otto Scheuer. Description of apparatus and results of experiments at the Darmstadt Technische Hochschule, with curves, diagrams and tables. 4500 w. Zeitschr f Elektrochemie—Sept. 1, 1905. No. 72129 G.

Tin Refining.

The Electric Separation and Refining of Tin by Means of Fluoric and Flusilicic Acids (Elektrische Zinnewinnung und Zinnraffination mit Fluss und Kieselflusssäure). Hans Mennicke. Discussion of the Betts and other processes. Serial. Part 1. 1500 w. Elektrochem Zeitschr—Sept., 1905. No. 72132 G.

ELECTRO-PHYSICS.

Matter.

Evolution of Inanimate Matter. Prof. G. H. Darwin. Excerpt from the presidential address before the British Assoc. giving a review of the modern theory of matter and atoms. 2500 w. Elec Rev, N Y—Sept. 2, 1905. No. 71716.

Radioactivity.

The Electrical Nature of Matter and Radioactivity. Harry C. Jones. The first of a series of articles giving an account of the most recent developments in physical science. 2000 w. Serial. 1st Part. Elec Rev, N Y—Sept. 9, 1905. No. 71723.

Radium.

The Production of Radium from Uranium. Bertram B. Boltwood. Discusses the experiments described by Mr. Soddy in three different papers, and describes experiments by the writer. 1800 w. Am Jour of Sci—Sept., 1905. No. 72029 D.

Reluctance.

An Experimental Determination of Air-Gap Reluctance. Charles H. Smoot. Aims to give a practical method of solving problems concerning magnetic reluctance and distribution. Ills. Discussion. 4000 w. Jour W Soc of Engrs—Aug., 1905. No. 71988 D.

GENERATING STATIONS.

Accumulators.

Accumulators with Reversible Boosters for Factory Installations. Ralph W. Birkett. An account of the writer's experience with a generating plant recently erected and managed by him in a large engineering works, showing that a battery thus equipped effects substantial economies in running expenses, and possesses other advantages. 4000 w. Serial. 2 parts. No. 71765 each A.

Acyclic Dynamo.

The Acyclic Dynamo of J. E. Noeggerath (Die Azyklische Maschine von J. E. Noeggerath). Clarence Feldmann. Illustrated description of the homopolar dynamo, a form of unipolar machine, invented by Noeggerath and developed by the General Electric Co. 1800 w. Elektrotech Zeitschr—Sept. 7, 1905. No. 72156 B.

Birmingham University.

Birmingham University Power Station. C. Alfred Smith. Illustrates and describes the equipment of this station which has been in successful operation for more than a year. 2200 w. Elec Rev, Lond—Aug. 25, 1905. No. 71764 A.

Bournillon.

The Hydraulic Plant of Bournillon, France. C. L. Durand. Illustrates and describes a recently erected large plant on the Bourne River, and its equipment. 2800 w. Elec Rev, N Y—Sept. 16, 1905. No. 72090.

Brooklyn.

The New Williamsburg Power Plant of the Brooklyn Rapid Transit Company. Describes the general arrangement of this new fireproof station, its boilers, forced draft, flues and stacks, coal and ash handling machinery, piping, pumps and heaters, turbines, electrical distribution, etc. Ills. 5600 w. St Ry Jour—Sept. 23, 1905. No. 72235 C.

New Power Plant of the Brooklyn Rapid Transit Company. Illustrated detailed description of the new Williamsburg station now under construction on the Wallabout Canal. 3200 w. Elec Wld & Engr—Sept. 23, 1905. No. 72214.

Bruck.

Hydro-Electric Plant of the City of Bruck, Austria. Franz Koester. Illustrated description of light and power station with capacity of 2700 horse-power. 800 w. Elec Rev, N Y—Sept. 2, 1905. No. 71719.

Commutators.

The Maintenance of Commutators and Brushes. S. Lees. An illustrated article discussing in the present number, the methods of truing up commutators. 3700 w. Elec Engr, Lond—Aug. 25, and Sept. 1, 1905. Serial. 2 parts. No. 71756 each A.

Electricity Supply.

The Supply of Electricity in Industrial Areas from a Municipal Point of View. William Hodgson. Read before the Incor. Munic. Elec. Assn., at Edinburgh. Remarks on present conditions and the demand for electric power, and the factors demanding municipal attention. 2200 w. Prac Engr—Aug 25, 1905. No. 71670 A.

Europe.

European Vertical Turbine Hydro-Electric Plants. Frank C. Perkins. Brief illustrated descriptions of the Brugg, Interlaken and Luterbach-Solothurn water-power installations. 1000 w. Mod Mach—Sept., 1905. No. 71685.

Erith.

See Street and Electric Railways.

Fife.

The Fife Electric Power Co.'s Station. Illustrated description of moderate size electric station near Dumfermline, Scotland. 800 w. Elect'n, Lond—Sept. 8, 1905. No. 71751 A.

The Fife Electric Power Company. Illustrates and describes particulars of the work which has been accomplished in the development of power supply in the country of Fife. 1800 w. Elec Engr, Lond—Sept. 1, 1905. No. 71758 A.

Framingham, Mass.

Power Plant of the Boston and Worcester Street Railway. Describes and illustrates a plant that operates an electric interurban system about 40 miles long. 1700 w. Ir. Age—Aug. 31, 1905. No. 71870.

Hamburg.

The Stations of the Hamburg Electric Works (Die Anlagen der Hamburgischen Elektrizitätswerke). Max Rupprecht. Fully illustrated descriptions of stations and substations. Direct current and storage batteries are used. Serial. Part 1. 3500 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1905. No. 72100 D.

Hanover.

The Municipal Central Power Station of Hanover, Germany. Illustrated description of a new alternating current plant and the features of special interest. 2800 w. Power—Oct., 1905. No. 72242 C.

Hartford.

The New Station of the Hartford Electric Light Company. Well illustrated description of the 5500 kw. plant at Dutch Point, Conn., equipped with Westinghouse-Parsons steam turbines to supplement the company's water-power plants.

2500 w. Elec Rev, N Y—Sept. 9, 1905. No. 71725.

History.

The Development of Electric Machines (Die Entwickelung der Elektrischen Maschinen). F. Tischendörfer. Paper before the Elektrotechnische Verein, giving a general historical review of the evolution of dynamos and electric motors and their design. Illus. 8000 w. Elektrotech Zeitschr—Aug. 24, 1905. No. 72152 B.

Incinerating Plant.

See Civil Engineering, Municipal.

Italy.

Hydro-Electric Plants in Upper Italy (Les Installations Hydro-Electriques de la Haute Italie). G. Semenza. Illustrated general description of stations and transmission lines in Northern Italy. 3 Plates. 10000 w. Mem Soc Ing Civils de France—Aug., 1905. No. 72182 G.

Linthal.

The Electric Station at Linthal, Switzerland (Das Elektrizitätswerk Linthal). Description, with illustrations and maps, of a small hydro-electric plant, with a high head of water, and generating three phase current. 2000 w. Schweiz Bauzeitung—Aug 26, 1905. No. 72117 D.

New York Edison.

Waterside Station No. 2 of the New York Edison Company. Well illustrated description of light and power station with 7500 and 8000 kw. turbo generators, with ultimate capacity of over 100,000 horse-power. 4500 w. Serial. 2 parts. Elec Wld & Engr. Sept. 2 and 9, 1905. No. 71708.

The New Waterside Station of the New York Edison Co. Illustrated detailed description of a turbine driven plant known as "Waterside Station No. 2." 3500 w. Eng Rec—Sept. 9, 1905. No. 71895.

Norway.

A Norwegian Hydro-Electric Power Plant. Dr. Alfred Gradenwitz. Illustrated description of the Kykkelsrud power station, on the Glommen River. 1400 w. Elec Rev, Lond—Sept. 8, 1905. No. 71770 A.

Organization.

The Organization of Working Forces in Large Power-Houses. W. P. Hancock. Gives an outline of the generating department organization of the Boston Edison Company. Also editorial. 6800 w. Cent Sta—Sept., 1905. No. 71980.

Philadelphia.

Power Plant Improvements of the Philadelphia Rapid Transit System. Illustrates and describes the Wyoming Ave. station, and the steam turbine Delaware Ave. station, and their equipment. 3000 w. Eng Rec—Sept. 23, 1905. No. 72223.

Power Equipment of the Philadelphia Rapid Transit Co. Illustrated descriptions of the direct-current stations, and the alternating-current station, sub-stations, and their equipment. 5800 w. St Ry Rev—Sept., 1905. No. 72219 C.

Glenside Sub-Station. Illustrates and describes this new rotary converter substation of the Philadelphia Rapid Transit Co. 3000 w. St Ry Rev—Sept. 15, 1905. No. 72221 C.

Puget Sound.

The Hydraulic Plant of the Puget Sound Power Company. Discussion of paper by Edwin H. Warner, printed in May *Proceedings*. 2500 w. Pro Am Soc of Civ Engrs—Sept., 1905. No. 72292 E.

Saut Mortier.

The Saut Mortier Transmission Plant. F. M. Bryan. Illustrated description of a 3000 horse-power hydro-electric plant in the Jura region of France, which transmits current to a great many small towns and villages. 2500 w. Am Electr'n—Sept., 1905. No. 71734.

Small Stations.

Combination and Operation of Small Central Station Plants. Abstract of a paper by Cleon L. Williams on "Erection and Maintenance of Electric Lighting Plants," before the International Association of Municipal Electricians. 2000 w. Elec Wld & Engr—Sept. 9, 1905. No. 71714.

Turbo-Dynamos.

Turbo-Dynamos (Turbodynamos). Prof. F. Niethammer. Address before the "Oesterr Vereinigung der Elektrizitätswerke", giving an illustrated review of the present constructions of dynamos for direct connection to steam turbines. 3000 w. Zeitschr f Elektrotech—Aug. 20, 1905. No. 72161 D.

Utah.

The Electric Light and Power Plant of Brigham City, Utah. W. P. Hardesty. Illustrated detailed description of a municipal light and power plant erected in 1902 and 1903. Describes the equipment and gives information of the service and low cost of power. 3200 w. Eng News. Sept. 7, 1905. No. 72038.

Walthamstow.

The Walthamstow Electric Lighting and Tramways Undertakings. Illustrated description of a new traction and lighting plant in which the energy is supplied from gas-driven plant, supplementary to the original installation. This is the largest gas-driven plant in England. 1500 w. Elec Rev, Lond—Sept. 15, 1905. No. 72084 A.

Welland Canal.

Electric Power from Welland Canal. Alton D. Adams. Describes the plant of the Hamilton Cataract Power, Light and Traction Co., Ltd., and discusses the possibilities of power development on this canal between Lakes Erie and Ontario, with a drop of 327 feet. 2000 w. Elec Rev, N Y—Sept. 2, 1905. No. 71718.

Willimantic.

The Electrical Equipment of the American Thread Company. Geo. A. Burnham. Description, with illustrations, of hydro-electric plant and distribution system at the Willimantic Mills, Conn. 1200 w. Am Electr'n—Sept., 1905. No. 71737.

Yorkshire.

The Yorkshire Electric Power Co.'s System of Generation and Distribution. Well illustrated detailed description of present condition of this undertaking, particularly of power station just completed at Thornhill, near Leeds. Serial. 1st part. 2000 w. Elect'n, Lond—Sept. 1, 1905. No. 71745 A.

The Yorkshire Electric Power Company. An illustrated description of a station for the supply of power, and its equipment. 2800 w. Elec Engr, Lond—Sept. 8, 1905. No. 71759 A.

LIGHTING.

Arc Lamps.

Comparison of Arc Lamps and Arc Lamp Systems in Relation to Economy (Vergleich der Verschiedenen Bogenlampenarten und Bogenlampenschaltungen in Bezug auf Ihre Wirtschaftlichkeit). Fritz Hoppe. Practical study of commercial types of arc lamps, with curves and tables. 3000 w. Elektrotech Zeitschr —Sept. 7, 1905. No. 72157 B.

Arcs.

The Dynamics of the Electric Arc and Arc Hysteresis (Ueber die Dynamik der Lichtbagenvorgönge und über Lichtbogenhysteresis). Herm. Th. Simon. Reprint from the *Physikalische Zeitschrift,* giving a comprehensive study of arc phenomena, with curves and diagrams. Serial. 2 parts. 9000 w. Elektrotech Zeitschr—Aug. 31, 1905. No. 72155 B.

Stroboscopic Observations of Alternating Current Arcs. Gives photographs, and describes methods used by Messrs. L. Lombardi and G. Melazzo in an experimental study. 1200 w. Sci Am Sup—Sept. 9, 1905. No. 71840.

Illumination.

The Distribution of Illumination in Artificially Lighted Spaces (Ueber die Helligkeitsverteilung in Künstlich Beleuchteten Räumen). F. Meisel. Theoretical discussion, with formulæ and diagrams. 2500 w. Elektrotech Zeitschr—Sept. 14, 1905. No. 72159 B.

Lamp Tests.

Efficiency of Incandescent Lamps. Abstract of paper by M. M. Lauriol and P. Janet before the Société Internationale des Electricians describing results of comparative tests on 110 and 220-volt lamps, with curves and tables. 1000 w. Elect'n, Lond—Sept. 1, 1905. No. 71747 A.

Municipal Lighting.

Municipal Electric Lighting. J. W. Wood. Read before the League of Am. Municipalities at Toledo, O. An account of what has been accomplished in this field in St. Louis, Mo. 3800 w. Munic Jour & Engr—Sept., 1905. No. 71690 C.

St. Louis Municipal Lighting. Joseph W. Wood. An account of conditions and cost by private companies and by municipal plant, showing a great saving by the latter. 2500 w. Munic Eng—Sept., 1905. No. 71943 C.

Tantalum Lamp.

Tests of the Tantalum Lamp. Abstract of paper by Prof. Wm. Ambler before the Ohio Electrical Association, with curves. 1500 w. Elec Wld & Engr—Sept. 2, 1905. No. 71711.

MEASUREMENT.

Condenser.

An Adjustable Condenser. Clyde C. Swayne. Illustrated description of brass plate, air-insulated condenser for wireless telegraphy and other high-potential work. 600 w. Am Electr'n—Sept., 1905. No. 71740.

Friction Losses.

See Mechanical Engineering, Measurement.

Insulation.

Insulation Testing. C. E. Skinner. Read before the Nat. Elec. Lgt. Assn. An illustrated article discussing the elements that should be considered in the design, selection and use of apparatus for making dielectric tests. 2400 w. Elec Jour—Sept., 1905. Serial. 1st part. No. 72031.

The Testing of High-Tension Insulating Materials. C. Kinzbrunner. An account of very complete experiments made at the Municipal School of Technology, Manchester, with curves and diagrams. Serial. Part 1. 2500 w. Elect'n, Lond—Sept. 8, 1905. No. 71750 A.

Meters.

Practical Information on Central Station Meters. Synopsis of questions and answers from the "Question Box" of the National Electric Light Association. 2000 w. Elec Wld & Engr—Sept. 2, 1905. No. 71710.

Motor Testing.

The Eddy Current Brake for Testing Motors. D. K. Morris, and G. A. Lister. The present number reviews the methods of motor-testing in use, presents the advantages of Eddy-current brakes, giving detailed description of new design and some results obtained. Illus. 2000 w. Elec Engr, Lond—Sept. 15, 1905. Serial. 1st part. No. 72082 A.

Standards.

Practical Standards for Electrical Measurements. Report of the committee of the British Association, recently presented in South Africa, on experiments for improving the construction of practical standards for electrical measurements. 4000 w. Elec Engr, Lond—Aug. 25, 1905. No. 71757 A.

MOTORS.

Air Compressor.

See Mechanical Engineering, Power and Transmission.

Applications.

Electric Motor Applications. J. Henry Klinck. Read before the Ohio Elec. Lgt. Assn. Illustrates numerous applications, discussing the conditions and methods applicable to each. 2000 w. Elec Jour—Sept., 1905. No. 72033.

Alternating.

The Operation of Alternating-Current Motors on the System of an Electric Light Plant of 1000 Kilowatts or Less Capacity. E. H. Beil. Abstract of paper before Ohio Electric Light Assoc. 800 w. Elec Rev, N Y—Sept. 2, 1905. No. 71717.

Induction Motors.

Measurement of the Slip of Induction Motors. C. V. Drysdale. Discussion of various methods, with illustrated description of some modifications of the stroboscopic method. 2400 w. Elect'n, Lond—Aug. 25, 1905. No. 71743 A.

Notes on the Induction Motor as Generator. T. P. E. Butt. Abstract of paper before the South African Association of Engineers, giving account of experiments in which the rotor of a 300 horse-power induction motor was supplied with direct current and rotated by a steam engine. 2000 w. Elect'n, Lond—Aug. 25, 1905. No. 71744 A.

Some Points About the Induction Motor. J. W. Welsh. Considers the effect of variation in the supply circuit. 1500 w. Elec Jour—Sept., 1905. No. 72032.

The Induction Motor Leakage Coefficient. A Press. Mathematical development of formula, with diagram, and comparison with other formulæ. 800 w. Elec Wld & Engr—Sept. 9, 1905. No. 71715.

Mining Machinery.

See Mining and Metallurgy, Mining.

Motor Rating.

Motor-Rating Diagram. C. P. Nachod. Outlines a convenient method of expressing the characteristics of a complete line of motors of one type, but of various speeds and outputs. 500 w. Elec Wld & Engr—Sept. 16, 1905. No. 72092.

Polyphase.

The Design of Polyphase Motors (Zur Berechnung von Drehstrommotoren). J. K. Sumec. Comprehensive discussion of the calculations with formulæ and diagrams. 4000 w. Zeitschr f Elektrotech—Aug. 27, 1905. No. 72162 D.

Single-Phase.

Latest Developments in Single-Phase Motors for Commercial Power Purposes. W. A. Layman. Read before the Pacific Coast Engng. Cong. Considers in some detail the developments being made in variable speed motors. 2200 w. Jour of Elec—Sept., 1905. No. 72097 C.

The Westinghouse Single-Phase Railway Motor (Der Einphasige Bahnmotor der Westinghouse-Gesellschaft). Clarence Feldmann. Illustrated description, with curves. 500 w. Zeitschr d Ver Deutscher Ing—Sept. 16, 1905. No. 72125 D.

Starting Switch.

See Electrical Engineering, Distribution.

TRANSMISSION.

Alternating Currents.

The Transmission of Power by Alternating Currents. Alfred Still. Considers single-phase, two-phase and three-phase transmission, and the points to be borne in mind when considering a scheme of power transmission to a distance by means of alternating currents. 3000 w. Elec Engr, Lond—Sept. 15, 1905. Serial. 1st part. No. 72080 A.

High-Voltage.

High-Voltage Power Transmission. Clarence P. Fowler. Discussion of the general question and of conductors, insulators and pole line. 1500 w. Am Electr'n—Sept., 1905. No. 71736.

Pole Lines.

Line Construction. B. L. Chase. Abstract of paper before the Ohio Electric Light Assoc., discussing poles, cross arms, insulators, pins, etc., for high-voltage lines. 1200 w. Elec Rev, N Y—Sept. 9, 1905. No. 71726.

Wire Spacing.

The Spacing of the Wires on High-Pressure Power Lines. W. B. Esson. Discusses this subject briefly and proposes that a uniform standard spacing be adopted of 1 ft. for every 10,000 volts pressure with a minimum spacing of 2 ft. 900 w. Elec Rev, Lond—Sept. 1, 1905. No. 71767 A.

MISCELLANY.

Costs.

Actual Cost of Energy Used in Driving a Small Engineering Works. Gives particulars supplied by a firm of engineers in Lancashire. 500 w. Elec Rev, Lond—Sept. 1, 1905. No. 71768 A.

Electromagnets.

Alternating-Current Electromagnets. Charles R. Underhill. Discussion of operation, with account of tests, and curves and illustrations. 1200 w. Am Electr'n—Sept., 1905. No. 71738.

Japan.

The Electrical Outlook in Japan. A review of the present condition of electrical matters bearing upon trade. 3300 w. Elec. Rev, Lond—Sept. 8, 1905. No. 71769 A.

Paris.

Electricity in Paris. An explanation of the action of the Paris Municipal Council and the results. 2000 w. Engng—Sept. 8, 1905. No. 71791 A.

Rates.

Maximum Demand. J. S. Codman. Discusses the best method of determining the demand in this system of charging for electric light. 2000 w. Elec Wld & Engr—Sept. 23, 1905. No. 72216.

Regulation of Electric Rates in Massachusetts. Alton D. Adams. A series of digests of the leading decisions of the Massachusetts Gas and Electric Commission. 2500 w. Serial. 1st part. Elec Wld & Engr—Sept. 2, 1905. No. 71709.

Standards.

Theory and Practice. E. A. N. Pochin. A criticism of statements, given by eminent professors, explaining the unreliability found in the information sought. 1200 w. Elec Rev, Lond—Sept. 1, 1905. No. 71766 A.

INDUSTRIAL ECONOMY

Accounting.

Accounting.—An Influence Towards Lessening Costs and Increased Efficiency. Kenneth Falconer. Read at the A. F. A. convention. Suggestions for planning methods of accounting. 1200 w. Foundry—Sept., 1905. No. 72270.

Birmingham University.

The Birmingham University. An account of the history of this enterprise with illustrated description of the buildings is given in the present number. 3500 w. Engng—Aug. 25, 1905. Serial. 1st part. No. 71771 A.

Canals.

The Inferiority of Canals as a Means of Goods Transport. Daniel Bellet. Discusses the canals of France and the conditions that made the work less costly than the usual construction of artificial waterways, and claims that such transportation is out of date, inefficient, and not cheap. 2700 w. Engng—Sept. 15, 1905. No. 72070 A.

China.

Chinese Concessions. Charles D. Jameson. Discusses the opposition to concessions for railways or mines to foreign syndicates and the reasons. 2800 w. Eng & Min Jour—Sept. 9, 1905. No. 71886.

Cost-Keeping.

Brass-Foundry Records and Costs. H. Deighton. General discussion, with forms for a moderate-sized foundry. 2000 w. Eng Mag—Oct., 1905. No. 71704 B.

Cost-Keeping. Dr. Edward Kirk. Does not consider the card system of much value in the foundry. 1800 w. Foundry. Sept., 1905. No. 72272.

Labor.

The Eight-Hour Day. R. W. Raymond. A discussion of the demands Mr. John Mitchell announces that he intends to present next April in behalf of the Mine Workers' Union. 1700 w. Eng & Min Jour—Sept. 9, 1905. No. 71885.

Liège Exposition.

The Mechanical Features of the International Exposition at Liége. Léon Ramakers. Illustrated description of the mining, metallurgical, railway and other mechanical and engineering exhibits. 2000 w. Eng Mag—Oct., 1905. No. 71705 B.

Organization.

The "Get Together" Principle in a Factory Organization. H. F. J. Porter. Remarks on the benefits from a conference of the employees, giving example, suggestions, etc. 3500 w. Am Mach—Vol. 28. No. 39. No. 72277.

Output Restriction.

The Restriction of Output. Abstract of a chapter in the report of the Bureau of Labor upon the restriction of output in the manufacturing trades, especially dealing with that regulation of output by the machinists' organizations. 4000 w. Ir Age —Aug. 31, 1905. No. 71871.

Pacific Coast.

Problems that Confront Engineering and Kindred Industries on the Pacific Coast. George W. Dickie. Read before the Pacific Coast Engng. Cong. Explains conditions and discusses cost of materials, cost of labor and other economic problems. 5500 w. Jour of Elec—Sept. 1905. No. 72096 C.

Valuation.

The Determination of Physical Values. Clinton S. Burns. Presents a method for the determination of valuations which it is believed is founded upon correct economics. 2500 w. Eng Rec—Sept. 16, 1905. No. 71973.

Works Management.

The Truce Between Capital and Labor. Carroll T. Fugitt. An illustrated article describing what has been accomplished at the National Cash Register factory, in Dayton, Ohio, to advance the health, happiness, and welfare of the employees. 4000 w. Cassier's Mag—Sept., 1905. No. 72251 B.

MARINE AND NAVAL ENGINEERING

Battleship.

A Government-Built Battleship. Illustration of the "Connecticut," now under construction at the Brooklyn navy yard, with a report of the creditable work, and the influence on private shipyards. 1000 w. Sci Am—Sept. 23, 1905. No. 72204.

Bennington Explosion.

Official Report of the Gunboat Bennington Explosion. Report of the court of inquiry which investigated the accident. Also editorial. 2500 w. Naut Gaz —Aug. 31, 1905. No. 71698.

Boilers.

See Mechanical Engineering, Steam Engineering.

Coal Endurance.

A Method of Calculating the Coal Endurance and Steaming Radius of War Vessels under Various Conditions. B. C. Bryan. Presents a method of tabulating and using data collected. 2200 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 71998 H.

Cruisers.

U. S. S. Charleston. M. E. Reed. Description and report of official trial. Ills. 15700 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 72004 H.

The U. S. S. Galveston. General description, with report of standardization, official, and endurance trials. 2000 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 71997 H.

Dry Docks.

Tests of the Cavite Steel Floating Dry Dock. A. C. Cunningham. An illustrated report of the docking tests of the "Dewey" dock. 1300 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 72000 H.

The Self-Docking Tests of the Steel Floating Dry Dock for Cavite, P. I. Leonard M. Cox. An illustrated account of the self-docking operations. 2000 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 72001 H.

"Fathomer."

U. S. Coast and Geodetic Survey Steamer "Fathomer" for Philippine Service. G. R. Putnam. Illustrations, with a brief outline of the principal features of interest from an engineering point of view. 1000 w. Eng News—Sept. 28, 1905. No. 72278.

Float.

Drouillard's Drifter Balloon Float. Describes a simple and practical apparatus designed to carry a line between a vessel in distress and the shore. 900 w. Sci Am—Sept. 16, 1905. No. 71901.

German Shipbuilding.

The Development of the German Shipbuilding Industry (Die Entwickelung der Deutschen Schiffbauindustrie). Hr. Stellter. Paper before the Schleswig-Holstein branch, giving history and statistics, with curves and table. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1905. No. 72104 D.

Gunboats.

U. S. Gunboats Dubuque and Paducah. W. N. Little. Illustration with description of the vessels, their equipment, and armament, and report of trials. 10500 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 71995 H.

Gyroscope.

Anschütz Gyroscope. Describes the invention of Dr. H. Anschütz-Kämpfe and its working. Also reports tests made by the Imperial German navy department, and states cases in which its use is of advantage. Ills. 2400 w. U S Cons Repts—June, 1905. No. 72018 D.

Japan.

The Dockyards and Ship-Building Plants of Japan. Chas. Albertson. The second part of this review, dealing with the private establishments for ship-building and repair work, with illustrations and a map. 4500 w. Engineering Magazine—October, 1905. No. 71703 B.

Lighthouses.

The Gibbs' Hill Lighthouse, Bermuda. Robert A. Cummings, and C. W. Reinhardt. Illustrates and describes the modern lenses and apparatus recently installed in the Gibbs' Hill lighthouse. 1000 w. Eng News—Aug. 31, 1905. No. 72025.

Modern Lighthouse Illumination. James Shirra. Read before the Engng. Assn. of N. S. W. Discusses recent practice in this field both as regards the light and methods of securing far-reaching power. 5200 w. Aust Min Stand—Aug. 2, and 9, 1905. Two parts. No. 71962 each B.

See also Civil Engineering, Construction.

Motor Yacht.

Suction - Producer - Gas - Motor Yacht "Emil Capitaine." General description, with illustrations, of an interesting gas engine and producer for marine propulsion. 1500 w. Prac Engr—Sept. 15, 1905. No. 72079 A.

Propellers.

A Comparison of the Performances of Propellers, U. S. S. Wyoming. Gives a comparison of the performances of the vessel with the original propellers and with a spare set built to conform to specifications furnished by the Bureau. Ills. 1300 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 71999 H.

The Dynamics of Screw Propellers. Prof. Robert H. Smith. Comments on recent articles, with a suggestion for an improvement in construction, claiming that the scientific mechanics of ship propulsion points clearly toward some form of jet propulsion. 5000 w. Engr, Lond —Sept. 1, 1905. No. 72006 A.

Salvage.

The Refloating of Ships (Le Renflouement des Navires). H. Pierron. An account of the refloating and salvage of wrecked ships, particularly of the "Chili," sunk near Bordeaux. 2000 w. Rev Tech —June 10, 1905. No. 72143 D.

Shear Legs.

180-Ton Shear Legs for the British Naval Dockyard. Illustration, with description, of the largest shear legs in the world, erected at the dockyard at Chatham. 700 w. Sci Am—Sept. 30, 1905. No. 72287.

Signalling.

Submarine Signalling. Reviews what has been done in this field, and gives an illustrated description of the apparatus devised for this purpose by the Submarine Signal Co., of Boston. Gives details of trials and other information. 2800 w. Engr, Lond—Sept. 1, 1905. No. 72010 A.

Steam Turbines.

See Mechanical Engineering, Steam.

Superheating.

See Mechanical Engineering, Steam.

Turbine Steamer.

The Turbine-Propelled British Coasting Steamer Dieppe. Illustrated description of the turbine machinery and its arrangement, with information concerning the vessel, and report of official trial. 2000 w. Naut Gaz—Sept. 14, 1905. No. 71920.

Vibration.

Vibration Phenomena of Steamships (Vibrationserscheinungen der Dampfer). Otto Schlick. General review of the present state of knowledge of ship and engine vibrations, and their remedies. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 16, 1905. No. 72123 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Beaufort.

The Beaufort Cars. Illustrates and describes the special features of these cars, such as the accessible magnets, igniters, ball-bearings to transmission and wheel axles, and three-point cantilever suspension to gear-box. 1000 w. Autocar—Aug. 26, 1905. No. 71663 A.

Clutches.

New Clutches Exhibited at the Paris Automobile Salon, in December, 1904 (Les Embrayages Nouveaux Exposés au Salon de Decembre 1904). H. André. Illustrations and descriptions of automobile clutches and gears. Serial. Part I. 1200 w. Rev Tech—June 10, 1905. No. 72147 D.

Commercial Vehicles.

Competition of Commercial Automobiles and Military Auto Trucks (Concours de Véhicules Industriels et de Fourgons Militaires). Ch. Dantin. Illustrated description of automobile trucks, omnibuses, delivery wagons, etc., in road competition under auspices of the Automobile Club of France and the French Department of War. Serial. 3 Parts. 7000 w. Génie Civ—Sept. 2, 9 and 16, 1905. No. 72138 each D.

The Atlas Gasoline Commercial Truck. Illustrates and describes the constructional features of interest. 2300 w. Automobile—Aug. 31, 1905. No. 71688.

Knox 6,000 Pound Air-Cooled Truck. Brief illustrated description of a machine for a heavy class of work. 800 w. Automobile—Sept. 14, 1905. No. 71905.

Dust.

Cause and Prevention of Dust from Automobiles. W. R. Cooper. Considers what has been accomplished in the special treatment of roads, and discusses the effect of the design of the car, and means of checking the dust. Ills. 4300 w. Nature—Sept. 14, 1905. No. 72017 A.

Fire-Engines.

"Merryweather" Self-Propelled Fire-Engines. Illustrations, with brief description. 500 w. Auto Jour—Sept. 9, 1905. No. 71956 A.

Lubricator.

The Albion Lubricator. Illustrated description of the mechanical lubricator on the Albion car. It is a multiple-feed lubricator, occupying very small space. 1000 w. Auto Jour—Sept. 16, 1905. No. 72075 A.

Manograph.

The Manograph—Its Utility and Construction. Illustrated detailed description of an apparatus for producing diagrams which enable the internal action of an engine to be seen. 1200 w. Auto Jour—Sept. 16, 1905. Serial. 1st part. No. 72076 A.

Omnibuses.

Electric Automotor Omnibuses. H. E. P. Cottrell. An illustrated series of articles considering what has been accomplished on the Continent, especially in France, to supply facilities of transportation of this character, their efficiency and cost. 3500 w. Engr, Lond—Sept. 1, 1905. Serial. 1st part. No. 72007 A.

Petrol Gauge.

The Murphy Petrol Gauge. Drawings and description of an apparatus for accurately indicating the amount of petrol in the tank of a motor vehicle. 900 w. Autocar—Sept. 16, 1904. No. 72077 A.

Pope-Tribune.

The Two-Cylinder 10 H. P. Pope-Tribune Car. Illustration, with detailed description of a light touring car. 1100 w. Autocar—Sept. 16, 1905. No. 72078 A.

Richard-Brasier.

The 40-50-H. P. Richard-Brasier Car. Illustrated detailed description of an extremely powerful touring model. 1600 w. Auto Jour—Aug. 26, 1905. Serial. 1st part. No. 71664 A.

Smoke.

The Cause and Prevention of Smoke on Motor Cars. Edward Butler. Considers the trouble due mainly to the faulty methods in use for lubricating the cylinders of the explosion motor. 900 w. Mech Engr—Sept. 9, 1905. No. 71960 A.

Street Sweeper.

Auto Street Sweeper. Brief illustrated description of a machine on trial in Paris. 300 w. Automobile—Sept. 28, 1905. No. 72286.

Waltham Car.

Orient 16-20 H. P. Air-Cooled Model de Luxe. Illustrated description of the 1905 model of the Waltham Mfg. Co. 1400 w. Automobile—Sept. 21, 1905. No. 72095.

COMBUSTION MOTORS.

Compression.

The Effect of Hydrogen on Gas Engine Compression. George M. S. Tait. Discusses the advantages gained by high compression in gas engines, and the necessity of putting the compression much lower to prevent pre-ignitions when hydrogen is present, and refers to a new system in which steam is replaced by cooled exhaust gases. 1200 w. Sci Am—Sept. 23, 1905. No. 72202.

Diesel Motor.

500-Horse-Power Diesel Motor, with Three Cylinders, at the Liége Exposition (Moteur Diesel de 500 Chevaux à Trois Cylindres, Installé à l'Exposition de Liége). Illustrated description. 1 Plate. 1000 w. Génie Civ—Sept. 9, 1905. No. 72141 D.

Economy.

Is Gas Power More Economical Than Water Power? H. G. T. Horace. Presents an analysis of costs aiming to show that gas power can be produced more economically. 1600 w. Power—Oct., 1905. No. 72244 C.

Electric Auxiliaries.

Utilization of Gas Engines in Connection with Long Distance Electric Transmission. J. Martin. Read before the Pacific Coast Gas Assn. Describes large gas engines to be used in California, for the generation of electricity in times of emergency on long distance transmission lines. Discussion. 5500 w. Am Gas Lgt Jour—Sept. 18, 1905. No. 71910.

Gas-Producers.

Economy of Gas-Producer Power Plants Where Heating is Necessary. J. H. Kinealy. A comparison of the fuel consumption of gas-producer plant and both non-condensing, and condensing steam plants. 2500 w. Eng News—Sept. 7, 1905. No. 72041.

Gas-Producer for Semi-Bituminous Fuel at the Liége Exhibition. Illustrates and describes an installation consisting of a double-combustion producer, of sufficient capacity to supply a 600-H. P. gas-engine, with a complete washing and cleaning plant, and a 60 cubic metre gas-holder. 1200 w. Engng—Aug. 25, 1905. No. 71777 A.

Lignite and Peat Gas Producers for Power Purposes (Braunkohlen- und Torfgeneratoren für Motorische Zwecke). Arnold Zlamal. Paper before the "Oesterr. Vereinigung der Elektrizitätswerke," giving a general discussion of such producers, with illustrated description of a couple of types. 1600 w. Zeitschr f Elektrotech—Sept. 3, 1905. No. 72163 D.

Suction Gas Producer Plants. Dr. Oskar Nagel. Explains the working of suction gas producer plants, and their advantages over the pressure gas producers. Ills. 2500 w. Cassier's Mag—Sept., 1905. No. 72255 B.

Gas Turbine.

Crossley and Atkinson's Turbine for Combustible Gases. Illustrated description of a recent patent. 1300 w. Mech Engr—Sept. 9, 1905. No. 71959 A.

Governing.

Governing of Gas and Oil Engines. Brief discussion of the merits of the several systems. 1000 w. Prac Engr—Sept. 8, 1905. No. 71957 A.

Liége Exposition.

Prime Movers at the International Exposition at Liége, 1905 (Bemerkenswerte Kraftmaschinen auf der Weltausstellung zu Lüttich 1905). H. Dubbel. Well illustrated descriptions of gas engines, with some account of steam turbines and reciprocating steam engines. Serial. Part I. 3 Plates. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1905. No. 72105 D.

Manograph.

See Mechanical Engineering, Automobiles.

Physico-Chemical.

Physico-Chemical Aspects of the Process of Combustion in Gas Engines (Physikalisch-Chemische Betrachtungen über den Verbrennungsprozess in den Gasmotoren). Prof. W. Nernst. Paper before the Verein deutscher Ingenieure, discussing thermodynamics and other theoretical aspects of internal-combustion motors. 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1905. No. 72106 D.

Producer-Gas Engine.

300-Brake-Horse-Power Rowden Producer Gas Engine. Illustrates and describes the arrangement and details of a new type of engine for producer-gas. It is of the two-crank vertical type with four cylinders, two working in tandem on each crank. 2800 w. Engng—Sept. 15, 1905. No. 72069 A.

Wood Gas.

Wood-Gas for Power Purposes and Gas-Generators. George M. Douglas. Read before the Inst. of Min. & Met. Describes the power plant for the concentrating works and mine of the Montezuma Copper Company, located at Nacozari, Sonora, Mexico, giving results of making of water gas with wood for fuel. 2800 w. Ills. Engng—Sept. 1, 1905. No. 71786 A.

HEATING AND COOLING.

Cooling Sheds.

The New Banana Cooling Sheds at Springfield, Mo. Illustrated account of train sheds and refrigerating plant, on the American Linde refrigerating air-circulating system, for cooling trainloads of bananas in transit. 1200 w. Ice & Refrig—Sept., 1905. No. 71700 C.

Exhaust Steam.

Waste Products of a Central Station. J. A. Bendure. Abstract of paper before Ohio Electric Light Assoc., giving experiences with exhaust steam for heating. 1000 w. Elec Rev, N Y—Sept. 2, 1905. No. 71722.

See also Mechanical Engineering, Steam.

Furnace System.

A Furnace System of Heating in a Country Store. Description and calculation of the performance of a warm air furnace heating system in a store building in Montgomery, N. Y., where for 17½ days in "zero weather," one ton of anthracite sufficed for satisfactory heating. Ills. 1800 w. Met Work—Sept. 16, 1905. No. 71909.

Refrigeration.

High-Speed Ammonia Compressor. Illustrated description of a type of machine embodying several important improvements. 700 w. Engng—Sept., 1905. No. 71782 A.

Shops.

Heating and Ventilating Railway Shops at Spencer, N. C. Describes an interesting example of a method of heating large open buildings, which involves the circulation of warmed air. Plans. 1500 w. Met Work—Sept. 16, 1905. No. 71908.

Station Heating.

Steam Heating for Central Stations. R. S. Wallace. Discusses some of the engineering questions which require study when it is proposed to attach a steam-heating system to an existing steam power control station supplying the public with electricity for light and power. 3500 w. Technograph—No. 19, 1904-1905. No. 72263 D.

Warm Air.

Modern Methods of Heating Residences with Warm Air Furnaces and Special Side Wall Registers. E. E. Dunning. Gives illustrations and descriptions of two methods of heating with a Warm Air Furnace and the cost of installation under each plan. 2200 w. Met Work—Sept. 2, 1905. No. 71682.

Heating a Residence in Van Wert, Ohio. D. A. Clark. Illustrates and describes a warm air furnace system in which twelve rooms are supplied by six hot air pipes. 1000 w. Met Work—Sept. 23, 1905. No. 72021.

HYDRAULICS.

Pump.

Variable-Stroke Pump. Illustrates and describes an electrically-driven variable-stroke pump designed by G. W. Sinclair to meet the needs of electrical generating stations, but applicable to other purposes. 1300 w. Engng—Sept. 1, 1905. No. 71779 A.

Stream Flow.

Work of the Hydrographic Branch of the United States Geological Survey in New England and a Discussion of the Methods Used for Estimating Stream Flow. H. K. Barrows. Ills. A discussion outlining the work done, and giving a résumé of the current meter method of estimating river flow. 9000 w. Jour Assn of Engng Socs—July, 1905. No. 72258 C.

Turbine Pumps.

Modern Turbine Pumps. Otto H. Mueller. Translation from *Zeitschrift des Vereines Deutscher Ingenieure*. Discusses the operation, efficiency, design, &c., comparing types, and giving results of tests. Ills. 3000 w. Ir Age—Sept. 21, 1905. No. 71945.

MACHINE WORKS AND FOUNDRIES.

Alumino-Thermics.

See Mechanical Engineering, Miscellany.

Bevel Gears.

Bevel Gear Chart. George J. Porter. Gives formulas covering cases where the shafts are less than right angles and greater than right angles, illustrating by examples. 700 w. Mach, N Y—Sept., 1905. No. 71846 C.

Boilers.

How to Lay Out a Locomotive Boiler. Frank B. Kleinhans. An illustrated article taking up the various parts of the boiler in their turn. 3000 w. Boiler Maker—Sept., 1905. No. 71686.

Brass Furnace.

Steele-Harvey Brass Furnace Tests. William T. Krause. Gives a report of tests made with this oil furnace. Also a brief illustrated description of this melting furnace. 2000 w. Ir Age—Sept. 21, 1905. No. 71946.

Car Shops.

Equipment of the New Plank Road Car Shops of the Public Service Corporation. Martin Schreiber. Well illustrated description of special tools and general equipment of shops at Newark, N. J. 5000 w. St Ry Jour—Sept. 2, 1905. No. 71731 C.

Casting Machines.

Casting Machines and Appliances (Giesserei-Maschinen und Einrichtungen). Illustrated description. Serial. Part I. 2000 w. Stahl u Eisen—Sept. 1, 1905. No. 72170 D.

Castings.

Casting Pipe in a Rotary Mold. C. B. Stravs. Describes a process of producing pipes and hollow ingots by centrifugal force, giving results obtained. Ills. 1500 w. Ir Age—Sept. 7, 1905. No. 71875.

Hard-Skinned and Knotty Castings. Walter J. May. Discusses the things that cause an abnormally hard skin on castings, and knotty iron. 1000 w. Prac Engr—Sept. 1, 1905. No. 71671 A.

Use of Ferro-Manganese and Ferro-Silicon in the Ladle. A report of tests made and the conclusions. 900 w. Foundry—Sept., 1905. No. 72268.

Casting Wagon.

An Electrically Operated Casting Wagon. Dr. Alfred Gradenwitz. Short illustrated description of a casting wagon at the Burbach Metallurgical Works, in Lorraine. 700 w. Ir Trd Rev—Sept. 7, 1905. No. 71828.

Chain Cables.

The Manufacture of Chain Cables. L. B. Powell. Gives extract from the lighthouse board requirements for chain, showing what must be secured in the way of iron, and describes the forming of the selected material into chains. 3000 w. Marine Rev—Sept. 7, 1905. No. 71801.

Cores.

The Use of Covering Cores. H. J. McCaslin. Gives illustrations covering the principal uses of this class of cores, with explanatory notes. 700 w. Foundry—Sept., 1905. No. 72269.

Crankshafts.

Machining Crankshafts for Motor Wagons. Illustrates and describes jigs and fixtures designed at an English shop for this work. 1400 w. Am Mach—Vol. 28, No. 35. No. 71862.

Cupolas.

Running Cupolas for Long Periods. Walter J. May. Suggestions for continuous working. Ills. 900 w. Prac Engr—Aug. 25, 1905. No. 71668 A.

Slagging a Cupola. David Rogers. Explains how the quantity of limestone required to form a slag in the cupola can be reduced to a system. 900 w. Foundry—Sept., 1905. No. 72271.

Cylinders.

Thick Cylinders. John S. Holliday. Gives a set of curves designed to save time and mathematical work involved in the solution of problems of Lamé's formula. 800 w. Mach, N Y—Sept., 1905. No. 71845 C.

English Methods.

The Way They Do It in England. P. W. Dillon. Relates the troubles of an American foreman in an English shop. 2000 w. Ir Trd Rev—Sept. 7, 1905. No. 71829.

Flanges.

Suggestions as to the Adaptability of a Universal Standard Flange List for Marine Work. Luther D. Lovekin. Discusses the need of a universal standard, and submits a series of flanges which have been designed with a view to overcoming all objections, explaining points in relation. 3800 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 72002 H.

Lap-Joints.

Why the Lap-Joint Fails. Engravings, with notes, showing why the lap-joint is so apt to develop cracks between the sheets. 400 w. Power—Oct., 1905. No. 72245 C.

Locomotive Rods.

Forging and Repairing Locomotive Motion Rods. S. Uren. Read before the Nat. R. R. Mas. Blacksmiths' Assn. Describes methods used in the Sacramento shops to meet the changed conditions. Ills. 900 w. R R Gaz—Vol. XXXIX., No. 11. No. 71914.

Liége Exposition.

Machine Tools at the Liége Exposition (Die Weltausstellung in Lüttich 1905. Die Werkzeugmaschinen). Paul Möller. Preliminary report, with illustrations and descriptions. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 9, 1905. No. 72109 D.

Machine Operation.

Phenomena of Machine Operation. John Richards. Read before the Tech. Soc. of the Pacific Coast. Gives observed facts and typical examples, especially in regard to centrifugal pumping, turbine water-wheels, and piston steam engines. 3500 w. Am Mach—Vol. 28, No. 35. No. 71864.

Milling Machines.

Methods of a New England Milling Machine Establishment. Gives half-tones and line engravings illustrating some of the special tools and methods used at works in Massachusetts. Explanatory notes. 1800 w. Am Mach—Vol. 28, No. 39. No. 72276.

Mold Drying.

Mold Drying. Illustrates and describes several systems of drying molds. The Shedden mold-dryer, the Littleton, and the Lochner. 2200 w. Ir & Coal Trds Rev—Sept. 1, 1905. No. 71678 A.

Molding.

Making the Pattern and Mold for the Side of a Power Screw Press. R. H. Palmer. Illustrated description of the methods used. 1500 w. Am Mach—Vol. 28, No. 36. No. 71868.

A New Multiple Molding Process for Relatively Deep Work. E. H. Mumford. Address before the New England Found. Assn. Illustrated description of the process developed by A. K. Beckwith. 1000 w. Met Work—Sept. 23, 1905. No. 72022.

Molding Machines.

Molding Machine Practice. F. W. Hall, in *The Patternmaker*. Remarks on recent molding machines, and their operation, with a description of the mounting of a casting. Ills. 2500 w. Foundry—Sept., 1905. No. 72273.

Selecting a Molding Machine—Molding a Cone Pulley. R. A. Bull. Suggestions for the selection of the right machine, and an illustrated description of method of making a special cone pulley. 2800 w. Am Mach—Vol. 28, No. 38. No. 71950.

Difficult Molding-Machine Work. R. Adams. Illustrates and describes a difficult case of three-parted work. 2000 w. Am Mach—Vol. 28, No. 38. No. 71951.

Up-to-Date Method of Molding. J. K. King. Discusses the introduction of molding machines into a foundry, the preparation of the machines and the points demanding attention. Ills. 2200 w. Am Mach—Vol. 28, No. 36. No. 71867.

Nut-Forming.

Nut-Tapping Machine. Illustrated description of bolt-forging, cutting and screwing machinery shown in operation at the St. Louis Exhibition. 1800 w. Engng—Aug. 25, 1905. Plate. No. 71772 A.

Pipe Founding.

Modern Pipe Founding. An illustrated description of the work as carried on at the Dimmick Pipe Foundry of Birmingham, Ala., and the United States Cast-Iron Pipe & Foundry Co., at Chattanooga, Tenn. 2500 w. Am Mach—Vol. 28, No. 36. No. 71865.

Pulleys.

Cone Pulley Radii. John J. Harman. Explains the method presented by Dr. L. Burmester, which is entirely graphical, and simple in application. 1200 w. Mach, N Y—Sept., 1905. No. 71843 C.

Screw Caps.

Electrically Welded Screw Caps and Bolts. Report of the Committee of the Franklin Institute, on Science and the Arts. Describes and approves the method originated by David J. Kurtz. Recommends the award of the John Scott legacy premium and medal. 1800 w. Jour Fr Inst—Sept., 1905. No. 71982 D.

Standards.

Foundry and Pattern Shop Standards. William H. Parry. Read before the A. F. A. Convention. Discussion of practices that could be improved by standardizing, with suggestions. 1400 w. Foundry—Sept., 1905. No. 72267.

Sturtevant Shops.

The New Plant of the B. F. Sturtevant Company, Hyde Park, Mass. Illustrated detailed description of the plant and its equipment. 3000 w. Ir Age—Sept. 28, 1905. No. 72275.

Thread-Miller.

Large Thread-Milling Machine. Illustrated description of a machine designed especially for cutting large worms, hobs, &c., taking work up to 12 inches diameter and 48 inches in length. 1400 w. Am Mach—Vol. 28, No. 37. No. 71869.

Tools.

Some English Tools. James Vose. Illustrates and describes a series of machine tools, designed to reproduce quickly and accurately any predetermined outline. 2200 w. Am Mach—Vol. 28, No. 36. No. 71866.

Valve Works.

Hopkinson's Valve Works at Huddersfield. Illustrated detailed description of these new works, which embrace the most commendable practice, and also their equipment. 4000 w. Engng—Sept. 8, 1905. No. 71787 A.

Welding.

See Mechanical Engineering, Miscellany.

Wheel Forging.

Car Wheel Forging. James H. Baker. Illustrates and describes improvements in forging, consisting of a peculiar distribution of the metal, of quick changing, registering and securing dies in position by power, while securing clean welded and forged metal in the tire. 1300 w. Ir Age—Sept. 7, 1905. No. 71874.

Worm Gear.

A Method of Making a Templet for Worm-Gear Tooth Patterns. John J. Smith. Illustrates and describes the method adopted in making a cast worm and gear. 3000 w. Am Mach—Vol. 28, No. 38. No. 71949.

An Oblique Worm-Drive Layout. William H. Raeburn. Diagrams and explanation of the methods employed in locating the various points and lines. 2000 w. Am Mach—Vol. 28, No. 35. No. 71861.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys. Percy Longmuir. Considers briefly the preparation of alloys, the influence of oxygen, especially in alloys containing copper as a base, and other features. Ills. 2200 w. Can Engr—Sept., 1905. Serial. 1st part. No. 72248.

Aluminium Steels and Alloys. Gives results of various investigators of these materials. 1000 w. Engng—Sept. 1, 1905. No. 71781 A.

Ferro Alloys. Auguste J. Rossi. Discusses their uses in the iron industry, especially considering titanium and its ferro combination in the electric furnace. Ills. 5000 w. Cassier's Mag—Sept., 1905. No. 72252 B.

Bronzes.

Bronzes and Brasses Used in Machine Construction and for Valves and Cocks. Ern. Roussel. Reports investigations made to determine the strength of the different bronzes and brasses used in machine construction and more particularly in locomotive building. 2000 w. 5 tables and figure. Bul Int Ry Cong—Vol. XIX., No. 6. No. 71991 G.

Cast-Iron.

Testing Cast Iron. E. L. Rhead. The present article considers principally tests of the running power of the metal, and shrinkage. 2500 w. Mech Engr—Sept. 9, 1905. Serial. 1st part. No. 71958 A.

Elbows.

The Bursting Strength of Standard Screwed Cast-Iron Elbows and Tees. S. M. Chandler. Abstract of a thesis presented to the Case School of Applied Science. Ills. Gives results of tests and incidents of interest. 700 w. Power—Oct., 1905. No. 72247 C.

Laboratory.

The Laboratory for the Testing of Materials of the Charlottenburg Polytechnic School of Berlin. L. Ramakers. A partial description of the Gross-Lichterfelde establishment for experimental study of materials, illustrating some of the modern testing machinery and instruments installed. 2500 w. Sci Am—Sept. 9, 1905. No. 71838.

Lubricants.

New Method of Testing Lubricants. Illustrates and describes the method and machinery used by the Gebrüder Körting Electrical Co., of Berlin. 700 w. U S Cons Repts—June, 1905. No. 72020 D.

Hydrocarbon Oils and Their Value as Lubricants, with a Few Practical Tests. Frank Harris Floyd, in *The International Steam Engineer.* Explains the qualities of a good lubricant, the refining of the hydrocarbon oils, tests, &c. 2400 w. Sci Am Sup—Sept. 30, 1905. No. 72290.

Manganese.

The Effect of Manganese in Low Silicon Cast Iron. H. C. Loudenbeck. Read at A. F. A. Convention. An account of tests made to show the effect of manganese on the chill and fracture of cast iron having a low per cent. of silicon. 1000 w. Foundry—Sept., 1905. No. 72274.

Packings.

Piston-Rod Packings. R. T. Strohm. Practical discussion, with illustrations of various types. 2000 w. Am Elect'n—Sept., 1905. No. 71735.

Painting Tests.

Proper Methods in Conducting Painting Tests. Gustave W. Thompson. Abstract of paper before the American Society for Testing Materials. 3000 w. Elec Rev, N Y—Sept. 9, 1905. No. 71724.

Pig Irons.

British Pig Irons for Foundry Use. P. Munnoch. Abstract of a paper read before the Cleveland (Eng.) Inst. of Engrs. Gives typical analyses of pig irons from different districts, and variations in analyses of pig irons, discussing the effect of the various elements, mixing by analysis, &c. 2000 w. Ir Age—Sept. 7, 1905. No. 71877.

Springs.

The Strength of Laminated Springs. H. E. Wimperis. An investigation made to determine results of a degree of accuracy sufficient to yield true deflections for all practical cases of springs. 2800 w. Engr, Lond—Sept. 15, 1905. No. 72061 A.

Steel.

Properties of Steel. F. M. Thomas. Considers the properties of commercial steels, and the effects produced by various modifications in chemical composition and treatment. 5000 w. Mech Engr—Sept. 2, 1905. No. 71673 A.

Steel as an Igneous Rock. Explains Professor Arnold's views in regard to this material, based on extensive study and testing. He regards steel as an igneous rock, more or less crystalline. 2000 w. Engng—Sept. 8, 1905. No. 71788 A.

The Elastic Properties of Steel at High Temperatures. Bertram Hopkinson. Read before the Royal Society. Describes experimental investigations of the elastic properties of steel and iron, ranging up to 800 deg. Cent., and for stresses greatly below that required to rupture the material. 2200 w. Engng—Sept. 8, 1905. No. 71793 A.

Structural Materials.

The Investigation of Structural Materials by the U. S. Geological Survey. Richard L. Humphrey. An account of the arrangements for the continuance of the valuable work carried on at the Louisiana Purchase Exposition, on a much more extensive scale. 2000 w. Eng Rec—Sept. 2, 1905. No. 71891.

Tantalum.

Tantalum. Gives the physical constants of pure tantalum, discussing some of its properties and alloys. 1200 w. Engng—Sept. 1, 1905. No. 71783 A.

See also Electrical Engineering, Lighting.

Tool Steel.

High-Speed Steel in the Factory. O. M. Becker and Walter Brown. The second article of this series discusses the controlling principles in introducing the new steel tools into the factory. 4000 w. Eng Mag—Oct., 1905. No. 71707 B.

Manipulating Tool Steel, Including the High Speed Varieties. R. A. Mould. Read before the International Master Blacksmiths' Assn. Deals with the quality, treatment, etc. 2000 w. Ry Mas Mech—Sept., 1905. No. 71819.

MEASUREMENT.

Calorimeter.

The Junkers Calorimeter as an Indicator of Heating Values (Das Junkers-Kalorimeter als Heizwertanzeiger). Jos. C. Breinl. Results of comparative tests and analyses of blast furnace gas. 700 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1905. No. 72103 D.

Centrifugal Stresses.

Systematic Method of Computing Centrifugal Stresses. Sanford A. Moss. Gives a convenient system for the computation of stresses in rotating bodies due to "centrifugal force." 1800 w. Mach, N Y—Sept., 1905. No. 71842 C.

Eccentric Weights.

Forces Due to Eccentric Weights Attached to Rolling Wheels. Calvin M. Woodward. Mathematical demonstration of the action upon horizontal and curved tracks of a heavy mass attached to rigid rolling wheel. 1400 w. Jour Assn of Engng Socs—July, 1905. No. 72260 C.

Friction Losses.

Separation of the Bearing and Air Frictional Losses of Rotating Machinery by Means of the Shape of the Retardation Curve (Trennung der Lager—und Luftreibungsverluste Umlaufender Maschinenteile aus der Form der Auslaufslinie). Fritz Roehle. Graphical and mathematical analysis of curves representing the observed decreasing speeds of rotating parts acted upon by friction. 1500 w. Elektrotech Zeitschr—Aug. 24, 1905. No. 72151 B.

POWER AND TRANSMISSION.

Air Plants.

Compressed Air and Defective Installation of Air Plants. William Wilhelm. Gives facts useful to engineers in the installation of air equipment. 1300 w. Mines & Min—Sept., 1905. No. 71808 C.

Conveyors.

Conveying Machinery for Loose Material (Technische Hilfsmittel zur Beförderung und Lagerung von Samuel Körpern). Prof. M. Buhle. Illustrated description of bucket and belt conveyors and their performance. 2000 w. Stahl u Eisen—Sept. 15, 1905. No. 72171 D.

Cranes.

Forty-Ton Block-Letting Titan. Illustrated description of a "Titan" crane just completed for Table Bay harbor, which works at a radius of 115 ft. Report of tests. 600 w. Engng—Aug. 25, 1905. No. 71773 A.

Details of Electric Travelling Cranes. Illustrates and describes the arrangement and details of the electric cranes for the Wallsend Slipway Company. 1800 w. Engng—Sept. 1, 1905. No. 71785 A.

Large, High-Speed Electric Traveling Crane (Elektrisch Betriebener Laufkran Grosses Dimensionen und Hoher Geschwindig keiten). E. Egger. Illustrated description of crane driven by polyphase current, and of 80 feet span and 10 tons capacity. 1 plate. 1600 w. Zeitschr f Elektrotech—Sept. 10, 1905. No. 72165 D.

Electric Traveling Crane of 30 Tons Capacity (Pont Raulant Electrique de 30 Tonnes). Illustrated description of a crane of 79 feet span, built by the Stuckenholz Works and exhibited in the machinery building at the Liége Exposition. 1 plate. 700 w. Génie Civ—Sept. 2, 1905. No. 72140 D.

Notes on Equipment for Electric Cranes. W. H. Wakeman. Suggestions for selecting cranes for a foundry or shop. 1500 w. Elec, N Y—Aug. 30, 1905. No. 71977.

Electric Compressor.

A High-Speed Electrically Driven Compressor for Colliery Work. W. Reavell. Abstract of paper before the South Wales Institute of Engineers, giving an illustrated description of an air compressor with four cylinders disposed radially in a circular casing. 3000 w. Elect'n, Lond—Sept. 1, 1905. No. 71749 A.

Electric Driving.

Electric Driving of Textile Mills. W. B. Woodhouse. Read before the Leeds Local Soc. of the Inst. of Elec. Engrs. States the advantages of electrical driving, its applications, etc. 3500 w. Elec. Engr, Lond—Sept. 8, 1905. No. 71760 A.

The Turbo-Electric Drive in Paper Mill Service. J. R. Bibbins. An illustrated account of the experience of the West Virginia Pulp and Paper Co., Piedmont, W. Va., which is reported as successful. 3500 w. Eng Rec—Sept. 2, 1905. No. 71887.

Elevators.

The Mabbs Electric Elevator. Illustrated description of a novel and successful machine that has been in service for nearly three years. 2800 w. Engr, U S A —Sept. 1, 1905. No. 71849 C.

Hoist.

An Electrically Operated Flat Rope Hoist. Dr. Alfred Gradenwitz. Illustrated description of a hoist constructed for the Lens Mining Co., France. 1200 w. Mines & Min—Sept., 1905. No. 71807 C.

Mechanical Handling.

Loading and Unloading Apparatus for Harbors (Lösch und Ladevorrichtungen für Hafenanlagen). Bruno Müller. Illustrated description of cranes and other mechanical handling apparatus for loading and unloading ships. Serial. 1st part. 3000 w. Schiffbau—Sept. 13, 1905. No. 72122 D.

Ore Handling.

The Handling of Iron Ore. Illustrated description of the Hulett ore unloading plant. 2200 w. Engr, Lond—Sept. 8, 1905. No. 72016 A.

Power Plant.

New Power Plant of the Heyworth Building, Chicago. Illustrated description of a plant for lighting, ventilating, heating, refrigerating and elevator service in a modern office building of 17 stories. 3000 w. Engr, U S A—Sept. 15, 1905. No. 71941 C.

STEAM ENGINEERING.

Air-Pumps.

Watson's Independent Twin Air-Pumps. Illustrations, with description of a good example of the form of pumps usually adopted in battleships, cruisers, and mail liners, in connection with large marine engines. 800 w. Engng—Sept. 8, 1905. No. 71792 A.

Boiler Explosion.

See Railway Engineering, Motive Power.

Boilers.

Experiences with Niclausse Boilers on the U. S. S. Nevada. A. M. Cook. Gives the writer's experience with these water-tube boilers, describing the troubles and ways of overcoming them. Ills. 5000 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 72003 H.

The Boiler Plant of the British Armored Cruiser "Roxburgh" (Die Kesselanlage des Englischen Kreuzers "Roxburgh"). Carl Züblin. Illustrated description of plant consisting of 17 Dürr water-tube boilers and 6 cylindrical boilers, and of trial runs. 1200 w. Schiffbau —Sept. 13, 1905. No. 72121 D.

Regulations for Care and Test of Steam Boilers. A copy of the rules recently put into effect by the Erie Railroad Co. 2200 w. Boiler Maker—Sept., 1905. No. 71687.

See also Railway Engineering, Motive Power.

Corliss Engines.

150-I.-H.-P. Corliss Engine at the Liége Exhibition. Illustrations with brief description. 400 w. Engng—Sept. 8, 1905. No. 71789 A.

Draft.

Notes on Draft. A. E. Dixon. Discusses chimneys, natural draft and the conditions affecting it, economical combustion, etc. 2000 w. Ir Age—Sept. 14, 1905. No. 71878.

Exhaust.

The Wheaton Variable Exhaust. Brief illustrated description with statement of advantages claimed. 400 w. Ry & Loc Engng—Sept., 1905. No. 71691 C.

Exhaust Steam.

The Utilization of Exhaust Steam by Means of Rateau Heat Accumulators and Low-Pressure Steam Turbines (Die Verwertung des Abdampfes durch Anwendung von Akkumulatoren und Niederdruckdampfturbinen System Rateau). Fritz Krull. Paper before the Mining and Metallurgical Congress at Liége, giving a description of system for utilizing the exhaust steam from steam engines, working intermittently, particularly winding engines. 12500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 2, 1905. No. 72177 D.

See also Mechanical Engineering, Heating and Cooling.

Feed Pump.

An Automatic Boiler Feed Pump. Henry F. Schmidt. The advantages of motor-driven or turbine-driven centrifugal pumps, with diagram. 900 w. Am Electr'n—Sept., 1905. No. 71739.

Feed-Water Heaters.

Open Feed-Water Heaters and Their Application. W. T. Edwards. Illustrated description of feed-water heaters and oil separators for power plants, particularly of the Cochrane type. 2000 w. Am Electr'n—Sept., 1905. No. 71742.

Fuel Test.

Investigation of the Heat Losses and the Heat Distribution with Incomplete Combustion (Beiträge zur Untersuchung des Wärmeverlustes und der Wärmeverteilung bei Unvollkommener Verbrennung). Paul Fuchs. Record of experiments with a fire-tube boiler and coal fuel. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 16, 1905. No. 72124 D.

Gas Fuel.

See Mining and Metallurgy, Mining.

Heat Transmission.

The Transmission of Heat from Air to Water through Corrugated Copper Tubes. Harry F. Benson. Gives formula for finding the proper amount of surface in a cooler, and mathematical solutions bearing upon this subject. 1600 w. Am Mach—Vol. 28. No. 35. No. 71863.

Oil Fuel.

The Use of Fuel Oil on the Pacific Coast. Illustrates and describes the more important features of oil handling for fuel purposes, and various applications. 1800 w. Am Mach. Vol. 28. No. 38. Serial. 1st part. No. 71948.

Oil Furnaces. John McMally. Read before the Ry. Mas. Blacksmiths' Assn. Presents some of the advantages, and the economy made possible by the low pressure system now used. Discussion. 2000 w. Ir Trd Rev—Sept. 14, 1905. No. 71906.

Packings.

See Mechanical Engineering Materials.

Portable Engine.

A New Four-Cylinder Portable Steam Engine. Translated from *La Nature*. Illustrates and describes the Lefevre motor having four cylinders which make it possible to run it as a compound engine in two different manners, or as a triple expansion engine. It is easily applied to automobile carriages and boats. 1200 w. Sci Am Sup—Sept. 23, 1905. No. 72207.

Power-Plants.

Modern Power Plant Design and Economics. Franz Koester. The third article of this series discusses the steam turbine and the reciprocating engine and their auxiliaries, with many illustrations. 3000 w. Eng Mag—Oct., 1905. No. 71706 B.

Smoke.

The Smoke Question. F. Haier. Lecture delivered before the Hamburg and Berlin branches of the Soc. of German Engrs. Discusses the relation between smoke development and utilization of fuels, and the ways and means of smoke abatement during firing. Ills. 12800 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 71996 H.

Steam Turbines.

The Steam Turbine. Prof. Storm Bull. Briefly reviews the history of steam turbine development, discussing the classification of types, the rapid introduction and the advantages over the reciprocating steam engine, giving results of tests of several kinds of turbines. Ills. Discussion. 8000 w. Jour W Soc of Engrs—Aug., 1905. No. 71990 D.

Steam Turbines as Applied to Ocean Liners. J. Harvard Biles. Abstract of a paper read before the British Assn. Briefly reviews the results of turbine steamers thus far completed, giving the writer's opinion that the turbines will completely displace the reciprocating engine in all moderate and high-speed lines. 2000 w. Elect'n, Lond—Sept. 15, 1905. No. 72085 A.

The Steam Turbine. A lecture by F. R. Low, with illustrations. Explains general principles governing steam turbines and describes the main characteristics of the several forms in use, especially with regard to their methods of using the steam. 4800 w. Power—Oct., 1905. No. 72243 C.

The Parsons Turbine (Die Parsonsturbine). F. Bauer. Paper before the "Oesterr. Vereinigung der Elektrizitätswerke," describing details and giving a comparative discussion of steam turbines. 2000 w. Zeitschr f Elektrotech—Sept. 3, 1905. No. 72164 D.

Superheating.

The Use of Superheated Steam in Engines (La Surchauffe Appliquée à la Machine à Vapeur d'Eau). François Sinigaglia. Paper before the Mechanical Congress at Liége, giving a general review of the subject, with illustrations and tables. Serial. Part I. 10000 w. Rev de Mécanique—Aug. 31, 1905. No. 72186 E + F.

The Use of Superheated Steam in Engines (Les Applications de la Vapeur Surchauffée aux Machines). Ch. Compère. Account of tests and description of apparatus. 8000 w. Mem Soc Ing Civils de France—Aug., 1905. No. 72183 G.

Superheated Steam Tests (Versuche mit Ueberhitztem Dampf). Otto Berner. Report to the Verein deutscher Ingenieure on tests conducted at the steam experimental station of the Bavarian "Revisions Verein," in Munich. 7000 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1905. No. 72108 D.

Superheated Steam in Locomotive Service. W. F. M. Goss. Discusses the development and present state of this latest phase of locomotive engineering, giving illustrations of the most promising inventions that have been introduced. 6800 w. Jour Fr Inst—Sept., 1905. No. 71986 D.

Superheating Ten-Wheel Engine C., St. P., M. & O. Ry. A short illustrated article giving particulars of interest. 6000 w. Ry Mas Mech—Sept., 1905. No. 71820.

Test of the Machinery of the "James C. Wallace" under Superheated and Saturated Steam. W. W. White. A description and report of tests carried out on this large freighter on the Great Lakes for the purpose of securing comparative data. Ills. 2800 w. Jour Am Soc of Nav Engrs—Aug., 1905. No. 72005 H.

Tube Cleaners.

The Effects of Mechanical Tube Cleaners on the Tube. William A. Parsons. A report of an investigation of the effects resulting from the use of mechanical tube cleaners, describing the methods used. Ills. 1300 w. Power—Oct., 1905. No. 72246 C.

Valve Gears.

Dr. W. F. M. Goss on Valve Gears. From a paper read before the So. & So. W. Ry. Club. Discusses the improvement of locomotive valve gear, with remarks on valve setting. 1500 w. Am Engr & R R Jour—Sept., 1905. No. 71694 C.

Valves.

Slide Valve versus Piston Valve. L. S. Allen. Read before the Traveling Engrs' Assn. A statement of the merits of the piston valve and its advantages over the slide valve. 3500 w. Ry & Engng Rev—Sept. 16, 1905. No. 71940.

Waste Heat.

Steam Boilers Worked by Waste Heat from Coal-Fired Reverberatory Furnaces. R. T. Cooke, and Percival Cooke. Illustrates and describes the proper arrangement for the economical working of the reverberatory furnace, and various types of boilers and their management. 4700 w. Cassier's Mag—Sept., 1905. No. 72256 B.

Water Softening.

Water Softening Plants. Remarks on the treatment of boiler waters, giving illustrated descriptions of a number of water softeners. 4500 w. Ir & Coal Trds Rev—Sept. 1, 1905. No. 71679 A.

MISCELLANY.

Alumino-Thermics.

Goldschmidt's System of Alumino-Thermics. Report of the Committee on Science and the Arts on the invention of Dr. Hans Goldschmidt. Briefly explains the methods of thermic-welding and the applications, recommending the award of the Elliott Cresson Medal. 1200 w. Jour Fr Inst—Sept., 1905. No. 71985 D.

Welding Stern Frame of Apache. Gives details and illustrations of the welding of the break on the shoe of this steamer by the use of thermit. 1000 w. Marine Rev—Sept. 14, 1905. No. 71921.

Welding Locomotive Frames with Thermit. J. A. B. Gibson. Illustrated description of this method of welding as applied at the Boulton shops of the Richmond, Fredericksburg & Potomac R. R. 700 w. Am Engr & R R Jour—Sept., 1905. No. 71697 C.

Drafting.

Drafting Room of the B. F. Sturtevant Co. Illustrated description of the drafting-room at the new plant in Hyde Park, Mass. 2000 w. Mach, N Y—Sept., 1905. No. 71841 C.

Instructions for Draftsmen. Edwin W. Beardsley. Instructions, mostly confined to principles, intended to be applicable to the practice of the average drafting-room. 1500 w. Mach, N Y—Sept., 1905. No. 71844 C.

Liége Exposition.

The German Machinery Industry at the Liége Exposition (Lütticher Weltausstellung. Die Deutsche Maschinenindustrie). General account of engineering and mechanical exhibits with illustrations. Serial. Part I. 3000 w. Stahl u Eisen—Sept. 15, 1905. No. 72173 D.

Ordnance.

Ordnance at the Liége Exposition, 1905 (Das Waffenwesen auf der Weltausstellung in Lüttich 1905). J. Castner. Illustrated description, principally of field artillery. 3000 w. Stahl u Eisen—Sept. 1, 1905. No. 72169 D.

The Latest 12-Inch Breech-Loading Wire-Wound Guns. Drawings and description of the breech mechanism for the 12-in. Vicker's gun. 1200 w. Engr, Lond—Sept. 8, 1905. No. 72015 A.

Plumbing.

Sanitary Plumbing and the Plumbers' Craft in Relation to the Dwelling-House. A. E. Hudson. Gives examples of unsanitary conditions and discusses the main principles of modern house drainage and sanitary plumbing. 6500 w. Plumb & Dec—Sept. 1, 1905. No. 71954 A.

Difficult Joint Wiping. An illustrated article describing methods of making wiped joints in difficult positions. 2000 w. Met Work—Sept. 16, 1905. No. 71907.

MINING AND METALLURGY

COAL AND COKE.

Briquetting Plant.

Washing and Briquetting Plant. Dr. Alfred Gradenwitz. Illustrated description of the plant for screening, washing and briquetting coal at the Altstaden mine, Oberhausen, Germany. 1400 w. Mines & Min—Sept., 1905. No. 71812 C.

Charcoal.

The Manufacture and Properties of Charcoal. S. H. Stupakoff. Considers the methods in vogue for making charcoal, its uses, properties, and characteristics. 2500 w. Ir Age—Aug. 31, 1905. No. 71872.

Classification.

The Classification of Coals. Marius R. Campbell. Presents a scheme for accurately defining the various classes of coal, which applies to lignites as well as to bituminous and anthracite coals. 4000 w. Am Inst of Min Engrs—Sept., 1905. No. 72298 C.

Coal Plant.

The Iselin Plant. F. L. Dixon. An illustrated description of the principal features of the model new coal plant at Iselin, Indiana County, Pa. 1800 w. Mines & Min—Sept., 1905. No. 71802 C.

Coke Manufacture.

The By-Product Coke Oven. W. H. Blauvelt. Explains the differences in structure and method of operation between the old beehive oven and the retort oven, arranged for the saving of the by-products, illustrating the most prominent systems of the latter. Gives a description of the operation of by-product coke ovens, and other information. Discussion. Ills. 9000 w. Jour W Soc of Engrs—Aug., 1905. No. 71987 D.

Coking Process for Poorly Coking Coal (Verkokungsverfahren für Schlechtbackende Kohle). Oskar Simmersbach. Illustrated description of the Schwarz process. 800 w. Stahl u Eisen—Sept. 15, 1905. No. 72172 D.

Colorado.

Coal Fields of Routt County, Colo. Describes one of the best coal fields of the Rocky Mountain region. 1500 w. Min Wld—Sept. 9, 1905. No. 71817.

Electric Power.

Earth in Collieries, with Reference to the "Special Rules for the Installation and Use of Electricity." Sydney F. Walker. Read before the Inst. of Min. Engrs. An explanation of the term and of the conditions usually found in mines as affecting electrical installations, and their designers. 3500 w. Ir & Coal Trds Rev—Sept. 15, 1905. No. 72074 A.

Explosions.

Can Explosions in Coal Mines, with Their Associated Toxic Fatalities, Be Prevented? B. H. Thwaite. Read before the Inst. of Min. Engrs. Presents the arguments showing that a removal of the coal dust would greatly lessen the danger, and describes an apparatus for effecting its removal. 3500 w. Ir & Coal Trds Rev—Sept. 15, 1905. No. 72073 A.

Cambrian Collieries Explosion. A report of the circumstances attending the explosion which occurred on March 10, 1905. 4000 w. Col Guard—Sept. 1, 1905. No. 71676 A.

Rush Run Mine Explosions. W. F. Paul. An account of the two explosions at Rush Run and Red Ash mines, West Virginia, March 18 and 19, 1905. 4000 w. Mines & Min—Sept., 1905. No. 71810 C.

Great Britain.

The Search for Coal Beneath the Red Rocks of the Midland Counties. Wolcot Gibson. From the summary of progress of the Geological Survey for 1904. Gives the more important results obtained from the examination of several borings. 3800 w. Ir & Coal Trds Rev—Sept. 8, 1905. No. 71967 A.

Indian Territory.

The Poteau Coal Mines. Prof. W. R. Crane. An illustrated description of the modern equipment and methods of working employed. 3500 w. Mines & Min—Sept., 1905. No. 71811 C.

Lancashire.

Leading Features of the Lancashire Coal Field Extended. Joseph Dickinson. Read before the Inst. of Min. Engrs. Outlines briefly information given in an earlier paper, and describes additional features, bringing the account up to date. 4000 w. Ir & Coal Trds Rev—Sept. 15, 1905. No. 72071 A.

Longwall Workings.

The Action, Influence and Control of the Roof in Longwall Workings. H. G. Halbaum. (Prize essay.) Gives conclusions drawn from experience and from mechanical and geological theory. 5200 w. Ills. Mines & Min—Sept., 1905. Serial. 1st part. No. 71806 C.

Peat.

The Utilization of Peat. Editorial review of processes tried and proposed for drying peat and preparing it for use on a commercial scale. 2300 w. Engng—Aug. 25, 1905. No. 71776 A.

Peat and Its Relation to Coal. A. Lakes. Explains what peat is, its natural history, where and under what conditions it is found, its chemical and fuel composition, and how it can best be utilized. Ills. 1000 w. Min Rept—Aug. 31, 1905. No. 71822.

Sampling.

The Commercial Value of Coal-Mine Sampling. Marius R. Campbell. Describes the method of sampling for the geological survey coal-testing plant at St. Louis, and gives a proposed method for general work. 3500 w. Am Inst of Min Engrs—Sept., 1905. No. 72299.

Truesdale Plant.

The Truesdale Plant. Begins an illustrated description of one of the most complete anthracite collieries, having the largest breaker in the field, which is electrically operated. 800 w. Eng & Min Jour—Sept. 2, 1905. Serial. 1st part. No. 71928.

COPPER.

Analysis.

Wholesale Copper Analysis. A. H. Jackson. Abstract of a paper read before the Incor. Inst. of Analysts, Assayers & Metallurgists, at Melbourne. A record of the electrolytic method used by Mr. Rhodin, for testing Muntz metal. Ills. 350 w. Aust Min Stand—Aug. 16, 1905. No. 71964 B.

Copper Sheets.

A New Process for the Manufacture of Copper Sheets, Tubes and Wire. Sherard Cowper-Coles. Revised paper, recently read before the Faraday Society. Illustrates and describes the various processes used to increase the current density by using mechanical means for keeping the copper from getting rough. 1500 w. Prac Engr—Aug. 25, 1905. Serial. 1st part. No. 71669 A.

South Africa.

Notes on Copper Deposits Near Tokar, Sudan. W. H. Shockley. Illustrations, with brief account of these deposits. 600 w. Min & Sci Pr—Sept. 9, 1905. No. 71927.

United States.

Copper Metallurgy in the United States (La Métallurgie du Cuivre aux Etats-Unis). F. Glaizot. General account of copper production and metallurgy, with illustrations and curves. 13000 w. Mem Soc Ing Civils de France—July, 1905. No. 72181 G.

GOLD AND SILVER.

Australia.

Australia's New Silver Field. John Plummer. Information concerning the recent discoveries of a silver-lead field at Coppabella, in New South Wales. 800 w. Min Wld—Sept. 23, 1905. No. 72239.

Mount Boppy Goldfield (N. S. W.). J. B. Jaquet. Report to the N. S. W. Dept. of Mines. Information concerning this mine and its development. 1500 w. Min Jour—Aug. 26, 1905. No. 71674 A.

Concentration.

Concentrating Pavilion of the United States Geological Survey, at Lewis and Clark Exposition. Waldon Fawcett. Brief illustrated description of a structure for experimental work in saving platinum from black sand. 1000 w. Mines & Min—Sept., 1905. No. 71803 C.

Cripple Creek.

The Future of the Cripple Creek District. G. E. Wolcott. Discusses the general conditions of the ore deposits and their bearings on the high cost of mining, the methods employed in mining and treating, and the future development. 2000 w. Min Rept—Aug. 31, 1905. No. 71823.

Fraser River.

The Source of the Fraser River Gold. Horace F. Evans. Discusses briefly the probable source of the gold found in the Fraser River placers. 2000 w. Min Wld—Sept. 2, 1905. No. 71813.

Hydraulic Mining.

Hydraulic Mining on Banner Placer, Colorado. Kirby Thomas. Describes arrangements made to secure a sufficient supply of water for hydraulic mining, and the methods of working. Ills. 1700 w. Min Wld—Sept. 16, 1905. No. 71924.

Mexico.

Guanajuato. James W. Malcolmson. Information concerning methods past and present; in this field more silver is said to have been mined than in any other district in the world. Gold is also found. 1200 w. Eng & Min Jour—Sept. 23, 1905. No. 72210.

Nevada.

Genetic Relations of the Western Nevada Ores. J. E. Spurr. Discusses especially the ore-deposit at Tonopah, and Silver Peak, comparing them with other regions, and giving conclusions regarding their origin. 10600 w. Am Inst of Min Engrs—Sept., 1905. No. 72305 D.

Placers.

What Constitutes a Placer. Arthur Lakes. Describes how placer deposits are formed, and the causes of barrenness of one gulch and the richness of another. 1500 w. Min Wld—Sept. 23, 1905. No. 72238.

River Channels.

Ancient Gravel Channels of Calaveras County, California. From the 12th Annual Report of the State Mineralogist of California. Map, with outline of the processes by which these ancient gold-bearing channels were formed is given in the present number. 1700 w. Min & Sci Pr—Sept. 9, 1905. Serial. 1st part. No. 71926.

Siberia.

Siberian Gold Mining. George E. Walsh. Gives the location and extent of some of the gold fields discovered, and some of the conditions which retard development. 2000 w. Mines & Min—Sept., 1905. No. 71809 C.

Sulphides.

The Newer Treatment of Broken Hill Sulphides. A. Selwyn-Brown. Describes several processes now successfully employed in the treatment of the immense bodies of tailing, culled zinc ores that have accumulated, awaiting the researches of metallurgists. 1200 w. Eng & Min Jour—Sept. 2, 1905. No. 71879.

Tropical Mining.

Mining in Tropical Regions. Abstract from *L'Industrie Aurifere.* Describes methods of placer exploitation in French Guiana. 1500 w. Min Wld—Sept. 9, 1905. No. 71818.

Veins.

The Magmatic Origin of Vein-Forming Waters in Southeastern Alaska. Arthur C. Spencer. A study of the source of the vein-forming waters of this region, describing the geology. 2800 w. Am Inst of Min Engrs—Sept., 1905. No. 72294.

Witwatersrand.

Present Stage of Metallurgy on the Witwatersrand. G. A. and H. S. Denny. Gives an outline of present practice, and alterative suggestions made by the writers, with reasons and causes. 7000 w. Min Mag—Sept., 1905. No. 72034 C.

The Witwatersrand Deep Electrical Plant. Illustrates and describes the electrical plant of the Witwatersrand Deep Gold Mining Co., Ltd., which is of the most modern type. 1500 w. Elec Engr, Lond—Aug. 25, 1905. No. 71755 A.

IRON AND STEEL.

Blast Furnaces.

Notes on the Physical Action of the Blast Furnace. J. E. Johnson, Jr. Discusses some of the physical and mechanical aspects of the blast-furnace process, pointing out its dependence in these respects on well-known laws. 12500 w. Am Inst of Min Engrs—Sept., 1905. No. 72304 D.

Blast-Furnace Calculations. J. L. Stevenson. Gives the methods by which to arrive at the shape and size of furnace and the necessary equipment for the production of the output decided upon. Ills. 2800 w. Engr, Lond—Aug. 25, 1905. No. 71794 A.

Effect of the Oxides of Carbon Upon Iron and Its Oxides. A review of investigations of the destruction of blast-furnace linings, giving results obtained from various sources. 2500 w. Engng—Sept. 15, 1905. Serial. 1st part. No. 72068 A.

The Use of High Percentages of Fine Ore in a Charcoal Blast-Furnace. Harry R. Hall. An account of successful work under adverse conditions. 1500 w. Am Inst of Min Engrs—Sept., 1905. No. 72303.

Blowholes.

Processes for Preventing the Formation of Blowholes in Steel Ingots (Die Verfahren zur Verhütung der Lunkerbildung in Stahlblöcken). R. M. Daelen. Paper for the International Mining Congress at Liége, giving illustrated descriptions. 800 w. Zeitschr d Ver Deutscher Ing—Aug. 26, 1905. No. 72102 D.

Preventing the Formation of Cavities in Steel Ingots. F. O. Beikirch in *Stahl und Eisen*. Describes a method based on the formation of a waste head. Ills. 1200 w. Ir & Coal Trds Rev—Aug. 25, 1905. No. 71677 A.

Cementation.

The Brittleness of Case-Hardened Soft Steel (Sur la Fragilité des Aciers Doux Cémentés). J. Lecarme. Account of researches to determine the real cause of the brittleness of steel due to the cementation process of surface hardening, with micrographs, and note by H. Le Chatelier. 3000 w. Rev de Métallurgie—July, 1905. No. 72189 G.

Chrome Steel.

Chrome Steel as a Commercial Product (Comment l'Acier Chromé est Devenu un Produit Industriel). A. Brustlein. Brief review of the history and applications of chrome steel. 3000 w. Rev de Métallurgie—July, 1905. No. 72188 G.

Magnetic Separator.

The Snyder Magnetic Separator. Frederick T. Snyder. Illustrated detailed description of a magnetic separator and its operation. 1000 w. Eng & Min Jour—Sept. 2, 1905. No. 71881.

Metallography.

The Technique of Microscopic Metallography (Sur la Technique de la Metallographie Microscopique). H. Le Chatelier. Practical directions for methods of research. 4000 w. Rev de Métallurgie—July, 1905. No. 72190 G.

Nitrogen Influence.

The Influence of Nitrogen on Iron and Steel (Influence de l'Azote sur le Fer et l'Acier). Hjalmar Braune. Showing that combined nitrogen, taken up in the course of manufacture, is the cause of brittleness in iron and steel, with micrographs and a note by H. Le Chatelier. 2500 w. Rev de Métallurgie—July, 1905. No. 72187 G.

Nodulating.

A Process for Converting Fine Iron Ores into Nodules. Illustrates and describes the plant and process. 2000 w. Ir Age—Sept. 7, 1905. No. 71873.

Nova Scotia.

The Iron Ores of Nova Scotia. Abstract from summary report of Geological Survey of Canada (Ottawa, 1905). Gives information concerning the iron ores of Nictaux and Torbrook, Annapolis Co., N. S. 3500 w. Can Min Rev—Sept., 1905. No. 71847 B.

Open Hearth.

Open Hearth Molten Metal Processes. Oskar Simmersbach, in *Stahl und Eisen*. Describes and compares the various methods which have been worked to use molten iron in open hearth practice. 5000 w. Ir Age—Sept. 7, 1905. No. 71876.

Open Hearth Furnace Comparisons. A. D. Williams, Jr. Gives a table showing hearth dimensions for 18 furnaces and the ratio between hearth area and capacity and the length and width, discussing matters related. 1700 w. Ir Age—Sept. 21, 1905. No. 71947.

Pyrites.

Pyrites Mining and Milling in Virginia. Robert K. Painter. Gives some average costs, discussing value of deposits, size of concentrate, dressing, &c. 1000 w. Eng & Min Jour—Sept. 9, 1905. No. 71883.

Roasting.

Kernel-Roasting. Herman Poole. Describes the various stages of roasting of pyrites, and the explanations of the causes of the action as given by various writers. Ills. 3200 w. Am Inst of Min Engrs—Sept., 1905. No. 72300.

Rolling Mills.

Electrically-Driven Rolling Mills. Ralph W. Birkett. A short account of, and deductions drawn from the writer's observations of the working of an electrically-driven mill recently erected at Queensferry. 4500 w. Engr, Lond—Sept. 8, 1905. No. 72014 A.

New Universal Rolling Mills (Neuere Universalwalzwerke). Fr. Fröhlich. Illustrated description of rolling mills at the National Tube Co.'s, Pittsburg, and at some Continental works. 1000 w. Zeitschr d Ver Deutscher Ing—Sept. 2, 1905. No. 72107 D.

An Armor Plate Rolling Mill. Illustrated description of a rolling mill, recently constructed to the order of the French Navy Department, and its operation. 500 w. Engr, Lond—Sept. 1, 1905. No. 72008 A.

Steel-Making.

The Bessemer v. the Open Hearth System. John Parry. A comparison, discussing the advantages and disadvantages of the two systems. 2000 w. Ir & Coal Trds Rev—Sept. 1, 1905. No. 71680 A.

Steel Sections.

The German Book of Standard Steel Sections for Structural and Shipbuilding Work (Deutsches Normalprofilbuch für Walzeisen zu Bau- und Schiffbau-Zwecken). Extracts from memoir by Prof. Heinzerling, giving a history of the committee of the Verein deutscher Ingenieure, on standard sections, and a report of the present committee, by F. Kinzlé and E. Schroedter, with diagrams and tables. 10000 w. Zeitschr d Ver Deutscher Ing—Sept. 9, 1905. No. 72110 D.

New I-Beam Sections in the German Standard-Section Book of Rolled Shapes? (Neue Doppel-T-Reihe im Deutschen Normalprofilbuch für Walzeisen?). Discussion of new sections proposed by committee of the Verein Deutscher Ingenieure. 3 Plates. 6000 w. Stahl u Eisen —Sept. 1, 1905. No. 72168 D.

Wrought-Iron.

The Manufacture and Characteristics of Wrought-Iron. A discussion of the paper by James P. Roe, read at the Washington meeting, May, 1905. 7000 w. Am Inst of Min Engrs—Sept., 1905. No. 72296 C.

The Manufacture and Characteristics of Wrought-Iron. Taylor Allderdice. A communicated discussion of the paper by James P. Roe, read at the May meeting. 1200 w. Am Inst of Min Engrs—Sept., 1905. No. 72302.

MINING.

Australia.

Ventilation and Sanitation of Mines in Western Australia. Extracts from report of Royal Commission. Considers dust in mines and mills, gases due to explosives, fumes from the cyanide process, etc. 3500 w. Min Rep—Sept. 14, 1905. No. 71922.

Blasting.

Blasting Coal in Bituminous Mines. J. T. Beard. States the conditions that have led to the excessive use of powder, and discusses the placing of shot, the location of the charge, the direction and depth of the hole, and the manner of firing. Ills. 3000 w. Eng & Min Jour—Sept. 23, 1905. Serial. 1st part. No. 72211.

Debris.

Control of Hydraulic Mining Debris in California by the Federal Government. Abstract of a lecture by Capt. Wm. W. Harts, at San Francisco, Cal., giving an account of what has been done and what is proposed in this great work. Ills. 4000 w. Min & Sci Pr—Sept. 2, 1905. No. 71830.

Electric Equipment.

New Electric Equipment for Two Belgian Coal Mines (Zwei Neue Bergwerksanlagen mit Elektrischem Antrieb in Belgien). Adolf Spier. Description of electric plants and machinery at coal mines near Mons and Liége, with diagrams of the hoisting operations. 7000 w. Glückauf—Sept. 2, 1905. No. 72175 D.

Up-to-Date Electrical Power Distribution. R. Loraine Gamlen. Read before the Inst. of Min. Engrs. Discusses the things necessary for success if a Power Company is to supply the power for mines. 4000 w. Ir & Coal Trds Rev—Sept. 15, 1905. No. 72072 A.

Uses of Electricity in Mines. Henry Willock Ravenshaw. Describes the various applications of electricity in general use in mines, giving facts from actual practice. Ills. 4000 w. Jour Soc of Arts—Sept. 1, 1905. Serial. 1st part. No. 71662 A.

Electrical Mining Notes. Sydney F. Walker. Discussion of machinery, locomotives, ignition of coal dust and of gas, earth and leakage and other topics. 2000 w. Elec Rev, N Y—Sept. 2, 1905. No. 71720.

Explosives.

Continental Explosives Testing Stations. Information from a report to the Home Secretary, on visits to certain explosive factories and testing stations in Belgium, Germany and Holland, the methods of testing and results. 4500 w. Col Guard—Aug. 25, 1905. No. 71675 A.

Jig.

A Hand Jig. William S. Thyng. Brief illustrated description of a hand jig which was used to good advantage in concentrating crude tungsten ore for the market. 700 w. Eng & Min Jour—Sept. 16, 1905. No. 71933.

Lead Mining.

Lead Mining in the Linares District, Spain. Norman Carmichael. An illustrated article describing the conditions obtained at Linares, one of the important producing districts of Spain. 5000 w. B C Min Rec—Aug., 1905. No. 71821 B.

Lead Mining in Southeastern Missouri. R. D. O. Johnson. Describes the deposits and methods of mining. 2300 w. Eng & Min Jour—Sept. 16, 1905. No. 71929.

Mine Gas.

An Interesting Utilization of Mine Gas (Ueber einen Interessanten Fall von Grubengasverwertung). Karl Fric. Gas from a coal mine at Dombrau, Austria, is used for fuel under a steam boiler. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 9, 1905. No. 72178 D.

Mine-Maps.

Geological Mine-Maps and Sections. D. W. Brunton. Recommends a more extended use of mine-maps, explaining method and giving drawings, showing how valuable they may be made. 1800 w. Am Inst & Min Engrs—Sept., 1905. No. 72297.

Mine Ventilation.

Progress in Ventilation of Victorian Gold Mines. F. D. Johnson. Describes the condition of these mines in the past and present, and some of the difficulties in bringing about better conditions. 2200 w. Min Jour—Sept. 16, 1905. No. 72066 A.

The Vitiation of the Air in Transvaal Mines. James Moir. Discusses (1) Air from Compressors, (2) Ordinary Working Mine Air, and (3) Gases after Blasting with Nitro-glycerine Explosives. 5000 w. Jour of Chem, Met & Min Soc of S Africa—July, 1905. No. 71961 E.

Roasting.

The Theory and Practice of Roasting. A. W. Warwick. A discussion of the scientific principles of roasting, based on practical experience and a large number of pyrometric observations and analyses. Ills. 4000 w. Min Mag—Sept., 1905. No. 72036 C.

Sampler.

An Emergency Sampler. W. Denham Verschoyle. Illustrates and describes an inexpensive sampling device and reports the tests made of it. 500 w. Eng & Min Jour—Sept. 16, 1905. No. 71930.

Winding Ropes.

Accidental Breakage of Winding Ropes in Mines. Prof. John Perry. Read before the British Assn. at Johannesburg. Gives several problems and the writer's method of solving them. Mathematical. 3000 w. Engr, Lond—Sept. 1, 1905. No. 72012 A.

MISCELLANY.

Asbestos.

Asbestos. E. B. Wilson. An illustrated article describing different varieties and their characteristics; the methods of milling and preparing the amphibole asbestos. 1000 w. Mines & Min—Sept., 1905. No. 71805 C.

Asphalt.

Asphalt in the Indian Territory. W. R. Crane. Describes the deposits giving information concerning the cost of production, development, etc. 1500 w. Eng & Min Jour—Sept. 9, 1905. No. 71884.

Assaying.

Assaying Tin and Tin-Lead Compounds. P. J. Thibault. Gives results of experimental investigations of the dry determination of silver. 1800 w. Aust Min Stand—Aug. 9, 1905. No. 71963 C.

Diamonds.

Diamonds. Sir Wm. Crookes. Abstract of lecture before British Assoc. describing the making of artificial diamonds, experiments on diamonds, etc. 4000 w. Elect'n, Lond—Sept. 8, 1905. No. 71752 A.

The Genesis and Physical Properties of Diamonds. Sir William Crookes. Abstract of a paper read before the Assn. Describes the mines of South Africa and the deposits, and discusses the theory of formation and origin. 3000 w. Min Jour—Sept. 9, 1905. Serial. 1st part. No. 71965 A.

First Aid.

First Aid to the Injured in Mines. M. J. Shields. The present article is introductory, explaining the growth of the movement of rendering first aid, and giving an account of the work as established in mines. 2200 w. Eng & Min Jour—Sept. 16, 1905. Serial. 1st part. No. 71934.

Flints.

Flints and Other Hard Rocks as Material for Tube Mills. Prof. Arthur Lakes. Explains the origin of flint and other hard rocks, used in tube mills for grinding ores. 1200 w. Mines & Min—Sept., 1905. No. 71804 C.

Furnace.

A Furnace for Metallurgical Research. Woolsey McA. Johnson. Describes a furnace designed for use in a metallurgical laboratory; the fuel used was natural gas. Ills. 1500 w. Elec-Chem & Met Ind—Sept., 1905. No. 72094 C.

Lead Smelting.

The Huntington-Heberlein Process at Friedrichshütte. A. Biernbaum. Translated from *Zeitschrift für das Berg-Hütten- und Salinenwesen.* An account of the introduction of this process at Tarnowitz, Prussia, where it has completely displaced the old processes of local smelting. 4000 w. Eng & Min Jour—Sept. 23, 1905. No. 72212.

The New Methods of Desulphurizing Galena. W. Borchers. Translation from *Metallurgie.* Also editorial. Discusses critically the reactions involved in the new methods given in the processes of Huntington-Heberlein, Savelsberg, and Carmichael-Bradford. 4200 w. Eng & Min Jour—Sept. 2, 1905. No. 71882.

The Lead Smelting Plant at Monteponi, Sardinia (Die Bleihütte zu Monteponi). E. Ferraris. Illustrated description of furnaces and other parts of plant, and operating results. 1 plate. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 2, 1905. No. 72176 D.

Lead Smelting Works at Monteponi, Sardinia. Erminio Ferraris. An illustrated article describing the works, their equipment and operation. 1400 w. Min Mag—Sept., 1904. No. 72035 C.

Mica.

Mica and the Mica Industry. George Wetmore Colles. The treatment is industrial rather than scientific or theoretical, and aims at setting forth the present, past, and probable future of mica-mining in this and other countries. 5000 w. Jour Fr Inst—Sept., 1905. Serial. 1st part. No. 71984 D.

Petroleum.

The Latest American Petroleum Discoveries. Day Allen Willey. An illustrated article describing the great expansion of the oil industry in the United States, west of the Mississippi River, and in the Southwest, and the uses made of the liquid fuel. 4000 w. Cassier's Mag—Sept., 1905. No. 72253 B.

Phosphates.

Sources of Supply and Methods of Manufacture of Phosphates and Potash Salts. Edward B. Voorhees. A brief account of the various sources of supply of natural phosphates especially in the United States. Also an account of the Stassfurt deposits of potash salts. 1800 w. Jour Fr Inst—Sept. 1905. No. 71985 D.

Platinum.

Test for Platinum (Die Platinprobe). Dr. Nordenskjöld. Reprint from *Tekinsk Tidskrift,* giving chemical processes for determining platinum, iridium, etc. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 9, 1905. No. 72179 D.

Quicksilver.

Terlingua Quicksilver District. William B. Phillips. Notes on the quicksilver industry in this district of Texas, describing the manner in which the cinnabar occurs in the upper cretaceous. 1200 w. Min Wld—Sept. 2, 1905. No. 71814.

South Africa.

South Africa Mining Progress. Ralph Stokes. Discusses the progress since the close of the war, explaining conditions in the gold fields, and the rise of the diamond industry. Brief notes are also given on other minerals found. 2800 w. Min Wld—Sept. 16, 1905. No. 71925.

Tin.

Alluvial and Lode Tin in Malaya. J. B. Scrivener. From the annual report of the Federated Malay States. Describes three mines of detrital tin associated with limestone, gives information of tin lodes, and briefly discusses the origin of the deposits. 2400 w. Min Jour—Sept. 9, 1905. No. 71966 A.

Tin Refining.

See Electrical Engineering, Electro-Chemistry.

Tonkin.

The Mineral Resources of Tonkin. Henry Charpentier. Information concerning the deposits of coal, iron ore, copper, tin, and manganese ores. 1800 w. Ir & Coal Trds Rev—Sept. 1, 1905. No. 71681 A.

Wolfram.

Wolfram in Queensland. B. Dunstan. From the Annual Progress Report, Geological Survey of Queensland, for 1904. Information concerning the localities, deposits, developments, etc. 2300 w. Queens Gov Min Jour—July 15, 1905. No. 71667 B.

Zinc.

The Silesian Zinc Industry. George P. Scholl. A report of the zinc industry in this district, its output, ore deposits, smelting, and other information. 4000 w. Min Mag—Sept., 1905. No. 72037 C.

The Quapaw Zinc District. W. R. Crane. Describes the deposits in this Indian Territory district, and the methods of mining and milling. Ills. 2300 w. Eng & Min Jour—Sept. 16, 1905. No. 71932.

Zinc Oven.

Cylinder Ovens for Zinc Production (Zylinderofen für Zinkerzeugung). Friedrich Kellermann. Illustrated description of vertical oven for poor, but easily smelted zinc ores. 1000 w. Glückauf—Aug. 26, 1905. No. 72174 D.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Train Breaking.

Breaking in Two of Long Trains, Passenger and Freight, at Slow Speeds, When Releasing Brakes, and Methods of Prevention. Read before the Traveling Engrs' Assn. Considers the forces which the draw bars and couplers have to withstand and some of the causes of break-in-twos. 3000 w. Ry & Engng Rev—Sept. 23, 1905. No. 72241.

MOTIVE POWER AND EQUIPMENT.

"Alton Limited."

The New "Alton Limited." Illustrated description of fine passenger equipment for this train. 1000 w. R R Gaz—Vol. XXXXIX., No. 9. No. 71853.

Boiler.

The Brotan Locomotive Boiler. H. W. Hanbury. Illustrated description of a novel water-tube locomotive boiler shown at the Liége exhibition, discussing its advantages and disadvantages. 2200 w. Engng—Sept. 1, 1905. No. 71780 A.

Car Framing.

End Shocks in Car Service and Provision for Same in Car Framing. A. Stucki. Discusses present service conditions, present car equipments, advantages of a standard to regulate both, and the best basis for such a standard. Ills. 2500 w. Pro Ry Club of Pittsburg—Sept. 29, 1905. No. 72099 C.

Cars.

75-Ton Steel Flat Car. Illustrated detailed description of cars built for the Pittsburgh & Lake Erie R. R. 700 w. Am Engr & R R Jour—Sept., 1905. No. 71695 C.

Drawbars.

Experiments on the Behavior of Elastic Drawbars, on the von Borries and Wick Systems. Mr. Fischer. Describes experimental investigations made by the Royal Berlin Railway Management, stating their object, describing trials, and giving results. 9000 w. 9 tables and figs. Bul Int Ry Cong—Vol. XIX., No. 6. No. 71992 G.

Some Remarks on the Drawbar Trials Carried Out by the Royal Berlin Management. J. Doyen. Remarks on the conclusions reached, drawing attention to weak points in the Berlin trials. 1600 w. Bul Int Ry Cong—Vol. XIX., No. 6. No. 71993 G.

Dynamometer Car.

The New Pennsylvania Dynamometer Car. W. O. Dunbar. Description given in a discussion before the Engineers' Club of Philadelphia. 2500 w. Am Engr & R R Jour—Sept., 1905. No. 71696 C.

Headlight.

Electric Headlight for Locomotives. Illustrated description of the Edwards electric headlight, which is in use in America, India, and South Africa. 600 w. Engr, Lond—Aug. 25, 1905. No. 71797 A.

India Train.

Royal Train for India. Illustrated description of the new train constructed by native labor, under European supervision, from raw material, for the use of the Prince and Princess of Wales on their Indian tour. 1200 w. Engng—Sept. 15, 1905. Serial. 1st part. No. 72067 A.

Locomotive Design.

Some Factors in British Locomotive Design. Charles S. Lake. An illustrated article considering improvements in power capacity of locomotives intended for maximum service on main lines of railway. 1200 w. Mech Engr—Aug. 26, 1905. Serial. 1st part. No. 71672 A.

Locomotive Explosion.

Explosion of a Locomotive Boiler at the St. Lazare Station, Paris (Explosion d'une Chaudière de Locomotive aux Abords de la Gare Saint-Lazare). Robert Dubois. Fully illustrated account of explosion and investigation into its causes. 6000 w. Bull d l Soc d'Encouragement—July 31, 1905. No. 72180 G.

Locomotives.

Combined Rack and Adhesion Locomotive for South Africa. Illustration and description of a powerful engine for assisting the heavy express trains over exceptionally severe gradients. 800 w. Sci Am—Sept. 30, 1905. No. 72289.

Consolidation 2-8-0 for the Colorado-Utah Construction Company. Illustrates and describes engines of great strength, recently completed. An interesting feature is the adjustable hood on the smoke stack. 400 w. Ry & Loc Engng—Sept., 1905. No. 71693 C.

Express Locomotives. A. A. H. Tokeley. Discusses the design of high-speed locomotives. 2800 w. Engr, Lond—Sept. 15, 1905. No. 72060 A.

Lehigh Valley Ten-Wheel Locomotive. Illustrates and describes engines principally remarkable for their great weight.

The total weight in working order is 199,200 pounds. The heating surface also is large. 250 w. Ry Age—Sept. 22, 1905. No. 72200.

New Bogie Tank Engines, Southeastern and Chatham Railway. Dimensions and illustrated particulars of engines designed for heavy suburban trains. They are fitted with spark arresters and fuel economizers. 700 w. Engr, Lond—Aug. 25, 1905. No. 71795 A.

New Locomotives for the Indian State Railroads. Illustrates and describes a bogie express engine, and a freight engine designed for Indian climatic conditions. 600 w. R R Gaz—Vol. XXXIX., No. 11. No. 71917.

New Locomotives—Natal Government Railways. Illustrated description of engines specially designed to work the mail traffic in the main line between Durban and Charlestown. 400 w. Engr, Lond—Sept. 15, 1905. No. 72064 A.

New Type of Bavarian Four-Cylinder Compound Locomotives. Charles R. King. Also editorial. Illustrated description of powerful new engines recently designed for hauling heavy trains, with explanatory notes and comments. 4000 w. Ry Age—Sept. 15, 1905. No. 71938.

Tandem Compound Freight Locomotive, N. P. Ry. Illustrated description of very heavy freight locomotives of the 2-8-2 type. 800 w. Ry & Engng Rev—Sept. 16, 1905. No. 71939.

Tank Locomotive for Egyptian Delta Light Railways. Dimensions and illustrations of a six-wheel coupled bogie tank engine, 2 ft. 5½ in. gauge. 300 w. Engng—Sept. 8, 1905. No. 71790 A.

Motor Cars.

Rail Motor Cars in Great Britain. J. F. Gairns. The present article states the advantages of these vehicles, gives a general classification, and illustrated descriptions of examples of steam cars. 4800 w. Cassier's Mag—Sept., 1905. Serial. 1st part. No. 72254 B.

Motor Railway Coach. Illustrated description of the steam rail motor coach introduced by the London and Northwestern Railway. 600 w. Engr, Lond—Sept. 15, 1905. No. 72063 A.

Railway Motor Coach. Illustrated description of the interesting engine used in the motor passenger carriage introduced on the Great North of Scotland Railway. 500 w. Engr, Lond—Sept. 1, 1905. No. 72011 A.

Steam Coach.

Stean Coach; Great North of Scotland Railway. Illustrations of coach and boiler with short description. 350 w. Engng —Aug. 25, 1905. No. 71774 A.

Superheating.

See Mechanical Engineering, Steam.

NEW PROJECTS.

Cape-to-Cairo.

Recent Progress on the Cape-to-Cairo Railway. J. Hartley Knight. Well illustrated account of the present state of the main line and branches to the coast, with map. 4000 w. Eng Mag—Oct., 1905. No. 71702 B.

China.

Railway Construction in North China, E. H. Rigby and W. O. Leitch, Jr. Extract from a paper read before the Inst. of Civ. Engrs. Principally a description of the Chinchou-Yingkow Section, with map. 4000 w. R R Gaz—Vol XXXIX. No. 11. No. 71916.

Florida Keys.

Steamboat Travels Over Proposed Site for Railroad to Key West. Russell B. Smith, in the *N. Y. Herald*. An account of a trip which gives some idea of this great undertaking. 1000 w. Naut Gaz—Aug. 31, 1905. No. 71699.

Sierra Leone.

Sierra Leone Government Railway. History and illustrated description of this narrow gauge railway, and its rolling stock. 2500 w. Engr, Lond—Aug. 25, 1905. No. 71799 A.

Western Pacific.

Plans of the Western Pacific. An account from the annual report of the Denver & Rio Grande, of the financial and other plans embodied in the creation of the line from Salt Lake City to San Francisco. 1600 w. Ry Age—Sept. 15, 1905. No. 71935.

PERMANENT WAY AND BUILDINGS.

Coal Piers.

New Lackawanna Coal Piers. Illustrated description of recently completed piers at Hoboken, N. J., which possess features of novelty and interest. 1800 w. Ry Age—Sept. 15, 1905. No. 71936.

Freight-Terminals.

The Chicago Freight Terminals of the Chicago & Northwestern. Gives maps and plans with description and information of the methods of handling the freight. 4500 w. R R Gaz—Vol. XXXIX. No. 11. Serial. 1st part. No. 71915.

Grade-Crossings.

Grade-Crossing Problems in St. Louis. Carl Gayler. Gives a short review of the history of railroading in St. Louis, and some of the cases of grade-crossings and their treatment. General discussion. Ills. 7000 w. Jour Assn of Engng Socs—July, 1905. No. 72259 C.

Grand Central Station.

The Grand Central Station Terminal

Improvements. An illustrated article explaining some of the difficulties in the construction of this new station in the heart of New York City. 1400 w. Sci Am—Sept. 16, 1905. No. 71902.

Rail Fastenings.

The Fastening of Rails to Cross-Ties by Means of the Collet Wooden Trenails (Sicherung und Befestigung der Schienen auf Holzschwellen durch Verdübelung nach System Albert Collet). George Schwabach. Well illustrated description and records of experience. Serial. 1st part. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 8, 1905. No. 72167 D.

Shops.

The New Shops of the Lehigh Valley Railroad at Sayre, Pa. Illustrated description. 1000 w. Ry & Loc Engng. Sept., 1905. No. 71692 C.

Steel Ties.

Railway Cross Ties of Cast Steel (Traverses de Chemin de Fer en Acier Moulé). Ph. Rousseau. Illustrated description of steel cross ties and rail fastenings invented by A. Gouchet, and used in France. 1500 w. Rev Tech—June 10, 1905. No. 72144 D.

Tracks.

Some Practical Points in the Double Tracking of Railways. Gives the opinions of the Pennsylvania, Union Pacific, and Baltimore & Ohio railways on the conditions which determine the capacity of single-track lines, with discussion of the work, and opinions of other railways on various phases. Also editorial on this subject. 6600 w. Eng News—Sept. 14, 1905. No. 72048.

Modern Track Construction. A. Morrison. From paper entitled "The Construction and Maintenance of a Railroad Capable of Taking Care of the Present Traffic and Rolling Equipment," read before the Roadmasters' and Maintenance of Way Assn. 1800 w. Ry & Engng Rev—Sept. 23, 1905. No. 72240.

Track Elevation.

Track Elevation on the Chicago and Northwestern Ry., Chicago. Illustrated description of important and difficult work under trying conditions. Retaining walls, overhead and subway bridges, street improvements, track elevation, signal plants, etc., are embraced in the work. 4300 w. Eng News—Sept. 7, 1905. No. 72042.

Train-Shed.

A Novel Train-Shed for the New Hoboken Terminal of the Lackawanna. Illustrated description of a departure in train-shed design, stating the advantages claimed. 700 w. R R Gaz—Vol. XXXIX. No. 9. No. 71852.

Water Softening.

See Mechanical Engineering, Steam.

Yards.

Passenger Coach Yards. From a pamphlet compiled by Prof. Oder and Dr. Blum on German and American practice. 2500 w. R R Gaz—Vol. XXXIX. No. 10. No. 71860.

New Freight Yard of the Burlington at Galesburg. Gives a map showing the situation at this important point, with plans and description of the yard arrangements. 1000 w. R R Gaz. Vol. XXXIX. No. 10. No. 71855.

TRAFFIC.

Freight.

Time Freight on the Chicago & Northwestern. Gives particulars of the system in use. Ills. 1000 w. R R Gaz—Vol. XXXIX., No. 9. No. 71854.

The Great Northern Line Freight System. Gives particulars of the system used. 900 w. R R Gaz—Vol. XXXIX. No. 10, No. 71856.

MISCELLANY.

Canadian Railroad.

A Government Railroad. Editorial on the present condition of the Intercolonial Railway of Canada, as stated by Mr. Emmerson, Minister of Railways and Canals. 2000 w. R R Gaz—Vol. XXXIX. No. 11. No. 71912.

C., H. & D. Sale.

The Cincinnati, Hamilton & Dayton Sale. Editorial on the sale of this road to the Erie, and the effects from the change of control. 1500 w. R R Gaz—Vol. XXXIX. No. 12. No. 72209.

Costs.

Units of Costs. A. H. Plant. Address at meeting of the Assn. of Am. Ry Accounting Officers, New York. 1700 w. Ry Age—Sept. 1, 1905. No. 71824.

Division Engineers.

The Division Engineer in Railway Work. Willard Beahan. A discussion of the qualifications desirable in a successful division engineer, and the character of his work, giving suggestions. 6800 w. Jour W Soc of Engrs—Aug., 1905. No. 71989 D.

English Railways.

Some English Railways. Editorial review of the returns of the first six months of the present year, with discussion of the traffic, service, etc. 2000 w. Engng—Aug. 25, 1905. No. 71775 A.

Government Control.

Government Control of British Railways. A brief study of the relations between the British Board of Trade and the railways of the United Kingdom.

2800 w. Ry Age—Sept. 15, 1905. No. 71937.

Railroad Commissions.

Powers, Duties and Work of State Railroad Commissions. Report presented at meeting of the Nat. Assn. of R. R. Com., Deadwood, S. D. A discussion of this subject. 3500 w. Ry Age—Sept. 1, 1905. No. 71825.

Valuations.

Railroad Valuations in State Reports. Abstract of a report by Prof. Harold M. Bowman, made for Bul. No. 21, of the Census Bureau. Briefly explains the systems of valuation provided for by the laws of the several states, giving a critical review of the systems and administrative reports. 4500 w. R R Gaz—Vol. XXXIX. No. 10. No. 71857.

The Census Office Railroad Valuation. An editorial discussion of the work of Prof. Adams and his assistants. 2500 w. R R Gaz—Vol. XXXIX. No. 9. No. 71850.

Railroad Taxes and Plans for Ascertaining Fair Valuation of Railroad Property. Report presented at the Nat. Assn. of R. R. Com., Deadwood, S. D. Considers the best means of taxing railroad properties, and the best means of determining the fair valuation of the properties. 2500 w. Ry Age—Sept. 8, 1905. No. 71827.

STREET AND ELECTRIC RAILWAYS

Belgium.

The Street Railway System of the Borinage. Dr. Alfred Gradenwitz. Illustrated description of this single-phase system in the Belgian Colliery district, and its equipment. 2000 w. Elec Rev, N Y—Sept. 23, 1905. No. 72213.

Brakes.

An Emergency Track Brake for Street Railways. F. F. Bodler. Illustrated description of the Slipper track brake used on street railway cars in San Francisco, Cal. 1000 w. Eng News—Sept. 28, 1905. No. 72282.

Brooklyn.

See Electrical Engineering, Generating Stations.

Brunnen-Morschach.

The Electric Rack Railway from Brunnen to Morschach (Die Elektrische Zahnradbahn Brunnen-Morschach). Well illustrated description of a three-phase rack railway near the Lake of Lucerne. Serial. 2 parts. 4000 w. Schweiz Bauzeitung—Sept. 2 and 9, 1905. No. 72119 each D.

Car Lighting.

Car Lighting. Robert N. Tweedy. Discusses the cost of the lavish illumination now demanded, the effect on the eyes, and gives points that should be taken into consideration when a car is being designed. 2000 w. Elec Rev, Lond—Aug. 25, 1905. No. 71763 A.

Cars.

New Standard Cars of the Chicago City Railway Company. Illustrated article describing the new features of these cars, with editorial comment. 6200 w. St Ry Jour—Sept. 16, 1905. No. 72089 C.

Car Shops.

See Civil Engineering, Mechanical Engineering.

English Construction.

English Street Railway Construction. Joseph Owen. Abstract of a paper read before the Incor. Assn. of Munic. and County Engrs. describing the rails and fish-plates, joints, and special work, tie-bars, bonds, etc. 3200 w. Eng News—Sept. 7, 1905. No. 72045.

Erith.

Erith Electric Tramways. Illustrated detailed description of this recently completed link in Greater London's system. 2500 w. Tram & Ry Wld—Sept. 14, 1905. No. 72086 B.

The Erith Electric Tramways. General description of tramway system of town on lower Thames, 13 miles from London. 2000 w. Elect'n, Lond—Sept. 1, 1905. No. 71746 A.

The Erith Electric Tramways. Illustrated description of the sections of the tramways of the Erith Urban District Council recently opened. 2500 w. Elec Engr, Lond—Aug. 25, 1905. No. 71754 A.

Freight Service.

I. The Electric Freight Railway Service. H. H. Polk. II. Some Consideration of Operation Involved in Changing from Steam to Electric Power on Railroads. D. McNichol. Two papers discussed together. 7500 w. Pro Iowa Ry Club—June 12, 1905. No. 72249 C.

Ground Return.

The Treatment of the Ground Return in Railroad Systems. Albert B. Herrick. Discusses how to improve this portion of the system with the least possible cost. The question of bonding and considerations bearing upon it. 2200 w. St Ry Rev—Sept. 15, 1905. No. 72222 C.

Jungfrau.

The Jungfrau Railroad. Reginald Gordon. Explains the difficult construction of this line, the progress made, and the portion now open to the public. 1200 w. R R Gaz—Vol. XXXIX. No. 11. No. 71918.

London Traffic.

The Extension of Traffic Facilities in London. Describes the situation, and discusses possible improvements; also considers the electrification of the underground roads, and the new lines in process of construction. 4800 w. Bul Int Ry Cong—Vol. XIX. No. 6. No. 71994 G.

Manila.

American Trolleys in Manila. Short general description with illustration. 700 w. Elec Wld & Engr—Sept. 2, 1905. No. 71713.

N. Y. Elevated Wreck.

The Elevated Railroad Wreck in New York. Brief illustrated description of the recent fatal accident at the 53rd street curve. 700 w. Sci Am—Sept. 23, 1905. No. 72203.

New York Subway.

New Paint Conditions Existing in the New York Subway. Maximilian Toch, in the *Jour. of the Soc. of Chem. Ind.* A report of investigations made of the conditions showing that a pigment compound with linseed oil is not fit for subway work. 1200 w. Eng Rec—Sept. 23, 1905. No. 72226.

New Zealand.

Christchurch Electric Tramways. James Drummond. Illustrated description of first municipal installation of electric traction in New Zealand, opened June 5, 1905. 4000 w. Tram & Ry Wld—Sept. 14, 1905. No. 72087 B.

Philadelphia.

Analysis of Transportation Conditions in Philadelphia. Discusses the traffic districts, conditions which effect transportation, the congestion problem, trends of travel, etc., giving many illustrations. 3500 w. St Ry Jour—Sept. 23, 1905. No. 72227 C.

The Philadelphia Subway and Elevated Railroad. Illustrated description of the new Market street trunk line of the Rapid Transit Co., the engineering features of the subway and elevated divisions, and the new bridge over the Schuylkill River. 6800 w. St Ry Rev—Sept. 15, 1905. No. 72218 C.

The Subway and Elevated Lines in Philadelphia. Describes the general conditions of the West Market street subway, the ventilation, Schuylkill River bridge, elevated structure, shops, etc. Illus. 5300 w. St Ry Jour—Sept. 23, 1905. No. 72234 C.

Department of Lines and Cables. Considers the direct current, and alternate current cables, underground conduits, overhead construction, telephone system, etc. of the Philadelphia system. Ills. 3000 w. St Ry Jour—Sept. 23, 1905. No. 72231 C.

Operating Methods in Philadelphia. An account of the organization, personnel, employment department, way bills, crossings, etc. 4500 w. St Ry Jour—Sept. 23, 1905. No. 72229 C.

Car Houses, Repair Shops and Rolling Stock. Illustrated descriptions. 1400 w. St Ry Jour—Sept. 23, 1905. No. 72233 C.

Distribution System of the Philadelphia Rapid Transit Co. Illustrated description of the methods of distribution both in the underground feeder system, high-potential lines, telephone lines, etc. 2000 w. St Ry Rev—Sept. 15, 1905. No. 72220 C.

Generation and Distribution of Power in the Philadelphia Rapid Transit System. Describes the general power scheme, the direct-current stations, alternating-current stations, new turbine station, etc. Ills. 9000 w. St Ry Jour—Sept. 23, 1905. No. 72232 C.

History, Organization and Financial Characteristics of the Philadelphia Rapid Transit Company. Reviews the early lines, race question, introduction of mechanical traction, operating factors, etc. Ills. 6500 w. St Ry Jour—Sept. 23, 1905. No. 72228 C.

Way and Roadway Matters in Philadelphia. Describes types of track construction, special work, shops, appliances, etc. Ills. 8500 w. St Ry Jour—Sept. 23, 1905. No. 72230 C.

See also Electrical Engineering, Generating Stations.

Philippines.

Public Engineering Work in the Philippines. Information from the report of the Philippine Commission concerning the public works in the provinces. Ills. 4000 w. Eng Rec—Sept. 23, 1905. No. 72225.

Physical Analysis.

The Physical Analysis of an Electric Railway Property. Albert B. Herrick. Discusses the character of a physical report, explaining some of the graphical methods used to represent the conditions. 3000 w. St Ry Jour—Sept. 23, 1905. No. 72236 C.

Power Stations.

The Power Station. Fred N. Bushnell. Read before the Am. Ry., Mech. & Elec. Assn. Describes the type of station most generally adopted for street railway work, the apparatus employed, and matters of interest, in regard to the service. Ills.

8000 w. St Ry Jour—Sept. 30, 1905. No. 72353 C.

The Power Station Load Factor as a Factor in the Cost of Operation. Lawrence P. Crecelius. Read at the convention of the Am. Ry., Mech., & Elec. Assn. Outlines a method employed by the United Ry. Cos. of St. Louis, in increasing the load factors of the main power stations, showing how the load factor plays a part in the cost of power per car-mile. 1800 w. St Ry Jour—Sept. 30, 1905. No. 72349 C.

Rail Joints.

New Rail Joints for Street Railways and their Installation on the Berlin Street Railway System (Neue Schienenstossverbindungen für Strassenbahnen und deren Einbau bei der Grossen Berliner Strassenbahn). Article from the *Elektrotechnische Anzeiger,* giving illustrated description of the Melaun and other rail joints. 2000 w. Mitt d Ver f d Förderung d Lokal u Strassenbahnwesens—Aug., 1905. No. 72148 D.

St. Gall.

The Electric Railway from St. Gall to Speicher and Trogen, Switzerland (Chemin de Fer Electrique de Saint-Gall à Speicher et à Trogen, Suisse). H. Somach. Illustrated description of direct-current railway, about 6 miles long, rising 900 feet. 2000 w. Génie Civ—Aug. 26, 1905. No. 72135 D.

Shops.

See Civil Engineering, Construction.

Signal System.

The Block System of the New York Subway (Das Blocksystem der New Yorker Untergrundbahn). S. G. Freund. Well illustrated description of signal system and safety appliances. 4000 w. Elektrotech Zeitschr—Sept. 14, 1905. No. 72158 B.

Single-Phase.

Single-Phase Alternating-Current Car Control, R. P. Jackson. Illustrated detailed description of a system of control adapted for the operation of cars or locomotives of any size. 1600 w. Elec Jour—Sept., 1905. No. 72030.

See also Electrical Engineering, Motors.

The Single-Phase Railway in Practical Operation. Gives an account of the operating experience of three equipments of this kind which have been in regular service some months. Ills. 4000 w. Elec Wld & Engr—Sept. 23, 1905. No. 72215.

Sprinkler.

Motor Sprinkler at Cologne. Illustrated description of a new type of motor sprinkling car in use in connection with the traction lines. 1200 w. Sci Am—Sept. 2, 1905. No. 71833.

Switzerland.

The Montreux-Oberland-Bernois Railroad. Frank C. Perkins. Illustrated detailed description of an interesting electric line traversing one of the most beautiful parts of Switzerland. 1200 w. R R Gaz—Vol. XXXIX. No. 10. No. 71858.

Third-Rail.

Under-Running Third-Rail for the New York Central. Illustrated detailed description of the type of third-rail under trial with a view to using it in the zone around New York. 1300 w. R R Gaz—Vol. XXXIX. No. 9, No. 71851.

New York Central Third Rail. Brief description with illustrations, of the under-contact type adopted. 700 w. Elec Wld & Engr—Sept. 2, 1905. No. 71712.

Under-Contact Third Rail for the New York Central. Illustrated description of current-carrying rail to be used in New York and vicinity. 600 w. St Ry Jour—Sept. 2, 1905. No. 71730 C.

New York Central Under-Contact Third Rail. Brief illustrated description of the plan adopted, which has the rail protected by a sheathing which leaves only the under surface exposed. 700 w. Ry Age—Sept. 1, 1905. No. 71826.

Toledo & Western.

Freight Development on the Toledo & Western Railway. Illustrated account of the growing freight business of an interurban electric railway in Ohio and Michigan. 3000 w. St Ry Jour—Sept. 2, 1905. No. 71728 C.

Track Changing.

Changing the Gauge of Tracks in East St. Louis. W. A. Bennett. Methods employed in changing electric street railway tracks from broad to standard gauge, with detailed cost of work. 1800 w. St Ry Jour—Sept. 9, 1905. No. 71733 C.

Tramways vs. Omnibuses.

Electric Tramways v. Motor Omnibuses. Gives reports of Mr. Stephen Sellon and Mr. W. Worby Beaumont, with other information which led to the decision to establish electric traction in Oxford. Also editorial. 6500 w. Elec Engr, Lond—Sept. 8, 1905. No. 71761 A.

Zossen.

The Berlin-Zossen High-Speed Tests of 1901. An extensive résumé of these electric railway experiments, particularly on train resistance and braking, with curves and tables. 8000 w. St Ry Jour—Sept. 9, 1905. No. 71732 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of The Engineering Magazine at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad.des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

Note—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* The Engineering Magazine.

South Africa.

The Geology of South Africa. By F. H. Hatch and G. S. Corstophine. Size, 9 in. by 6 in. pp. vii, 339. Price, 21 shillings. London: Macmillan and Co., Limited. New York: The Macmillan Company.

This is a work including the results of both the official results of government geological surveys and the researches of private investigators, the whole constituting an excellent description of the geology of a portion of the world now attracting much attention. The book is of especial value as forming a systematic arrangement of the results of the investigations of the non-official worker in South African geology, arranging in coherent form matter which would otherwise be inaccessible and scattered through the pages of scientific journals of many lands in many languages. Both of the authors of this work have been engaged in geological work in South Africa for many years, both at the Cape and in the Transvaal, where they have had many opportunities of discussing the numerous problems which have been forced upon them. This has enabled the authors to appreciate very fully the valuable work of other geologists in the South African field, and given them opportunity of removing some of the difficulties which lie in the way of the full realisation of the interesting nature of South African geology. The work is admirably illustrated with photographs, sections, and maps, the latter including a geological map of South Africa, on a scale of 1 : 5,000,000 and a geological map of the Transvaal on a scale of 1 : 1,250,000.

Lathe Work.

Engineers' Turning. A Handbook for Working Engineers, Technical Students, and Amateurs. By Joseph Horner. Size, 8½ by 5½; pp. xii, 404. Price, 9 shillings. London: Crosby Lockwood and Son.

There have been numerous books written upon the subject of the lathe itself, but comparatively few of these have discussed the actual use of the machine, the subject of turning, as considered apart from the machine upon which the work is done. It is this phase of shop work which Mr. Horner discusses, and he has succeeded in producing a valuable and interesting volume. The lathe itself is given a general examination, and the author then passes to the consideration of the tools with which the work is performed, the sources of error, and the general methods of testing for accuracy. Methods of supporting the work are then considered, followed by a discussion of drilling, boring, and allied operations. The important subjects of screw-cutting and turret-work are given separate chapters, while special work, such as grinding, fitting, and other departments of lathe work are successively considered. The use of high-speed steels is considered, and the conditions under which it can be used to advantage, the work closing with instructions from the various makers of modern tool steels as to the best methods of handling their products.

Mr. Horner has succeeded in producing a valuable and interesting book upon one of the most important departments of machine-shop work and one of a kind of which there are unfortunately too few available.

BOOKS RECEIVED.

Etude Théorique et Pratique de l'Incendie. Par Félicien Michotte. Price, 15 francs. Paris: Vve. Ch. Dunod.

Engineering Chemistry. By Thomas B. Stillman. Price, $4.50. Easton: The Chemical Publishing Co.

Modern Refrigerating Machinery. Translated from the German of Prof. Hans Lorenz by Thomas H. Pope; with additional chapters by H. M. Haven and F. W. Dean. Price, $4.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Graphic Methods of Machine Design. By Arthur H. Barker. Price, 3 shillings 6d. Manchester: The Technical Publishing Company, Ltd.

The Mechanical Equipment of Collieries. By C. M. Percy, completed and edited by Frank Percy and George H. Winstanley. Price, 21 shillings. Manchester: James Collins & Kingston, Ltd.

Machine Shop Tools and Methods. By W. S. Leonard. Price, $4.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXX. DECEMBER, 1905. No. 3.

AN ENGINEER'S LIFE IN THE FIELD ON THE ISTHMUS.

By Fullerton L. Waldo.

Mr. Waldo's article follows and amplifies the lines drawn by Mr. John F. Wallace, in his contributions to this Magazine in the preceding three issues, by making clear the fundamental soundness of the Panama Canal proposition, and the nature of the temporary difficulties which have hampered the execution of the plans. A fuller discussion of this point will be found in our Editorial Comment pages.—THE EDITORS.

BOYD EHLE AND HIS PALUNKA MEN.
Travel by dugout canoe on the upper Chagres, at Dos Bocas.

WHEN the new Panama Canal Company turned over to American engineers the job of digging "the big ditch," about two-fifths of the excavation for a lock canal was said to have been done. Among the assets received by the transfer was a lot of dredging and excavating machinery, which was newly painted and whitewashed—in so far as it lay along the railway track—to be seen by the Panama Canal Commissioners as they rode past. With this machinery, it was supposed by some over-trustful persons, the remaining three-fifths of the digging might, in part at least, be done. The late Mr. George S. Morison said no person responsible for the execution of the canal work should be compelled to use the French machinery, and he was just about right. Mr. Morison had

THE PANAMA WATER FRONT, AS SEEN FROM THE SEA AND THE SHORE.

no tact, but he had common-sense and a constructive imagination which enabled him to forecast the event from the beginning. "I hate to eat my lunch with Morison," said one of our foremost electrical engineers to me,—"he always quarrels with the waiter; but I'd trust his judgment sooner than that of any other engineer I know." It was Mr. Morison who advocated putting a match to Colon, with its filthy hovels, and rebuilding the town at a higher level—an idea which any drastic scheme of sanitation must include. Mr. Morison said furthermore that the first two years of work at Panama would have to be devoted to eradicating the results of four centuries of sanitative neglect on the part of the Spaniards: the filth-heaps under the houses, the polluted wells and malarial swamps, the germ-peddling mosquitoes described in Dr. Howard's admirable monograph. The workmen must be adequately housed, and—a prime requisite—good water must be supplied in sufficient quantity.

Instead of adopting Mr. Morison's scheme of prevision and provision, which was a matter of engineering, the War Department permitted the congestion of the Isthmus with a lot of contractors' supplies, prematurely ordered, which is a matter of bureaucracy and maladministration. A resident engineer who went to the Isthmus a year ago had to wait six fuming weeks to get his instruments from the storehouse. The rule ought to be rescinded by which everything in the line of tools or supplies needed by the man in the field is chained up in a government warehouse immediately upon its arrival at the Isthmus. Panama is no place for red tape; nature has imposed conditions sufficiently hard without the superaddition of vexatious official restrictions. One engineer needed mosquito bars for his party, and there were plenty of mosquito bars in the government storehouse. But the weary process of department routine and red-tape kept him waiting so long that he got impatient and stole the mosquito nets, for which larceny he was reported "higher up"—not high enough up, however, to let it be advertised that the administration, at the dictates of a military administrator, withholds from the civil engineers the necessities of life in the tropics, in order to comply with the technicalities of departmental legislation. Col. Roosevelt had the same sort of trouble in the Cuban campaign, as his book on the Rough Riders testifies, and Kitchener in India is similarly handicapped by Downing Street in London. The military *régime* at Panama, in so far as the furtherance of engineering efficiency is concerned, is a failure; in so far as the maintenance of official orthodoxy is concerned, it is a great success.

THE CHAGRES RIVER AT JUAN MINA.

Now let us see what has actually been done since American engineers went to Panama a year and a half ago.

The *crux* of the whole project, as everybody knows, is the control of the Chagres River in flood: the excavation at Culebra is a matter of keeping steam-shovels at work till a volume of earth greater than the cubic contents of Cheops' Pyramid is removed. A great many people think they know just how the Chagres can be made a tractable feeder for the Canal, and many plans have been submitted to the Commission, each indisputably superior to all the rest, which would save the Government nebulous millions of dollars. Mr. Morison's plan was to build a dam at Bohio, creating a large lake with an island —"Bunau Varilla Island"—in the middle, in which lake the water brought down in flood-time by the Chagres might be stored. Recent investigations have shown that the bed-rock at the site of the proposed dam is at much greater depth, and the deep-lying strata are much more permeable by water, than was indicated by the borings upon which Mr. Morison based his project. The man who stood closest to Mr. Morison's engineering concepts—his lieutenant in the field, Mr. Boyd Ehle—has in the year past under the chief-engineership of Mr. John F. Wallace, made discoveries in the Chagres valley which supply a rational alternative to Mr. Morison's great design, and a working basis for that alternative.

Mr. Ehle first went to the Isthmus with Chief Engineer Anecito G. Menocal (dean of all Isthmian surveys and surveyors) on the Nicaragua survey of 1889. Of his engineer assistants, Carpenter, Anderson, and Boltz had been with Mr. Ehle in Nicaragua; Hayes, Clark, Wells, and McMorrow in the United States; while Obensham, Lindsay, Hortenstine, and Archer were recent graduates of the noted technical school at Blacksburg, Virginia.

Camping chiefly under their hats and sleeping where night found them, Mr. Ehle's own party ran a line through the Continental Divide for an eight-mile tunnel spillway to the Pacific, to handle the great floods of the Chagres valley in the rainy season. Meanwhile a party in charge of R. H. Anderson was doing similar work in the Gatun valley on the north side of the Chagres, locating a second and much shorter tunnel spillway (about four miles) into the Gatuncillo river, whence the line runs into Manzanillo bay, utilizing from Gatun a diversion channel already cut by the French. More recent and more extended surveys have shortened the route. These two tunnel

PALM AVENUE AT ANCON.

POLE SHACKS WITH THATCHED ROOFS.

spillways are to tap a lake formed by a dam at Gamboa, which a third detail of engineers was busy locating while the spillway parties were engaged on opposite sides of the projected lake-area. Plans were made for a dam of concrete, and débris from Culebra, to a height at elevation 200 feet above sea level (about 150 feet above the valley floor). This would safely hold water to elevation 190 feet, forming a lake which would extend nearly 30 miles up the Chagres valley. The Gamboa dam and the two tunnel spillways Mr. Ehle estimates will result in a saving of $26,000,000 on Mr. Wallace's estimate for a lock canal. His official estimates for the two spillways and the dam are given at the end of this article. His very valuable technical commentary on these estimates gives a clear idea of what these surveying parties have accomplished toward the practical solution of perhaps the most difficult engineering problem at Panama.

The first detail—Mr. Ehle's party—established their headquarters at Bas Obispo and started to tunnnel a line up the Chagres valley into the Chilibre drainage. It was not possible to advance a foot without hacking one's way through a tangle of creepers by means of the *machete.* Lizards and gaudy snakes crawled and scuttled everywhere. Buzzards hovered against the blazing tropic sun, monkeys jabbered from the trees and parrots screamed, and insect pests were superabundant about the heads and eyes of the lightly-clad transitmen and levelmen. Amid the profusion of red

A GROUP OF MACHETEROS, JUAN MINA.

and yellow orchids and parasitical air-plants, humming-birds hung and darted, while the ground was alive with "leaf-cutter" ants that climbed the trees and cut out triangular bits of leaves, which they carried away in regularly marshalled columns to grow the fungus on which they feed their larvæ. Here and there one came upon the footprints of the tapir ("mountain cow") or the small tropical deer. A species of grouse and a kind of wild turkey, with jet-black plumage and ruff, allied to the Australian cassowary, furnished an occasional welcome variety in the camp fire. Once in a while a monkey was cooked and eaten, but the appearance of the skinned animal was so suggestively human that few of the college-bred men from the North fancied the diet. The gayest of butterflies and moths—some of them bright blue—lent additional gracenotes of flickering color. But, to tell the truth, it was sometimes hard to appreciate the beauties of Nature in the debilitating tropical heat and humidity, and the plague of insects was almost unendurable. Hundreds of ticks and red-bugs, brushed from every leaf, attached themselves to the skin and produced festering sores; at night the men scratched themselves till they fell asleep from sheer exhaustion, and then went on scratching with involuntary galvanic motions. Chigoes ("jiggers"), a kind of flea, laid eggs under one's toenails; in time a white sac with black specks appeared, which broke upon the maturity of the embryonic fleas and itched intolerably. The *roncho,* a parasite of the ringworm class, came with the friction of rain-soaked garments, and spread in forms like minute crocus-blossoms all over the body. In-

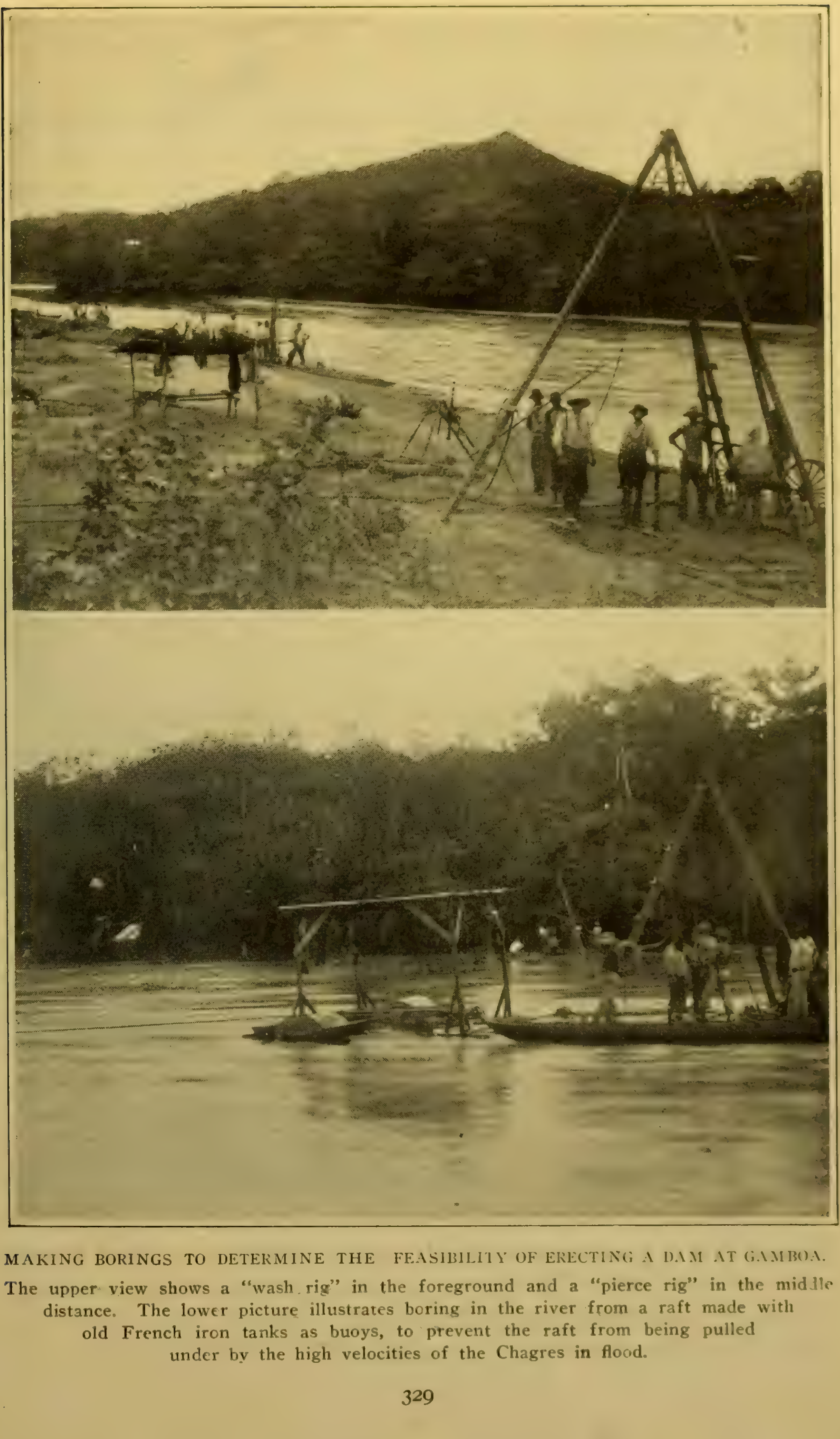
"IN PAJAMAS."

An engineering field party in costume adapted to the climate.

dolent ulcers, induced by poisoned scratches, had to be burnt out with lunar caustic, which meant, of course, lifelong scars. Neither last nor least of the malignant insect parasites was the *gussano,* which when first ensconced looks like a bad boil; if left to mature a worm an inch long is produced, which grows with its head inward (like the intestinal parasites of the hog) and breathes through its tail. It is easy enough for the stay-at-homes and "cabinet surveyors" to belittle the effect of such things on the man in the field; the fact remains, that bad water and bad air and the resultant service conditions of demoralization have been the real causes of failure, hitherto, at Panama.

AN ENGINEER'S CAMP UNDER CANVAS.

The first inland camp of the Ehle party was established on the Chilibre River at the junction of that torrent with its main tributary, the Chilibrillo. The usual procedure in camp-building was to clear a space with *machetes* and erect pole shacks, with forked sticks to support a ridge-pole and vine-lashed rafters, thatched with palm fronds overlapping to a thickness of some four inches. These shacks were open on every side to wind and sun. Provisions came from the Panama Railroad commissary to Bas Obispo, and thence by *cayuca* (canoe) up the Chagres and the Chilibre, the canoes under the skilful management of natives with iron-shod poles. The Chagres was here a beautiful stream, a few hundred feet in width, seeming



MAKING BORINGS TO DETERMINE THE FEASIBILITY OF ERECTING A DAM AT GAMBOA.

The upper view shows a "wash rig" in the foreground and a "pierce rig" in the middle distance. The lower picture illustrates boring in the river from a raft made with old French iron tanks as buoys, to prevent the raft from being pulled under by the high velocities of the Chagres in flood.

little to deserve its evil reputation as its clear waters flowed over a gravel bottom between their banks of clay, at an average rate of four miles an hour—except for swirling corners where the *palunka* men had to fight a current of seven or eight miles. They would steal up like a trout about to take a falls, and then dash directly into the rapids, men at bow and stern holding the boat's course true, until, amid triumphant yells, the strain was slackened on the bending poles and the dug-outs shot into smooth water again.

OBISPO LOCK, FROM THE NORTH.

Showing abandoned French machinery on the bank.

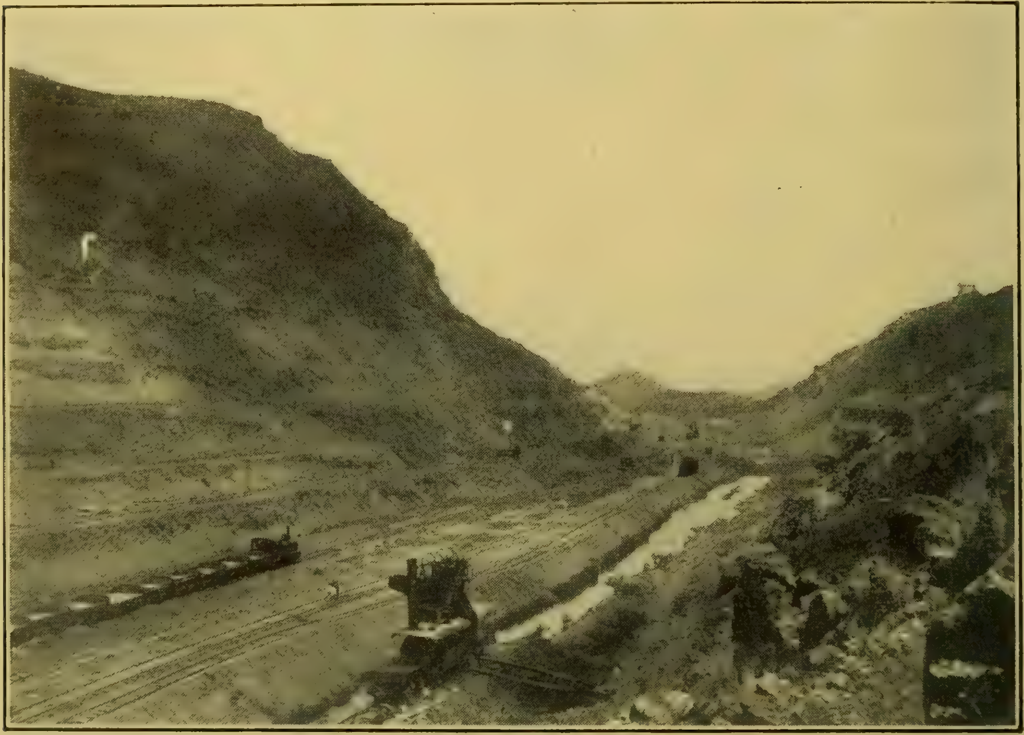
Camps were re-established whenever the tramp to and from the site of the day's operations got too long. Along the course of the lower Chilibre, narrow gullies were avoided, since cloud-bursts of rain often turned mere rivulets into roaring torrents. At the third camp at the foot of the Continental Divide, where the Chilibre turns to the west, the party found the river-bed strewn with boulders, sometimes thirty feet in diameter, infested with colonies of bats which fluttered in the faces of the surveyors. The main survey line here crossed the Divide and followed the Lajas valley (a part of the Pacific drainage), the Lajas being a typical mountain stream with steep falls near its source, tamed into a placid current a few miles further on. From the main survey line surveys and reconnaissances were made over the adjacent country, to determine the shortest crossing for the tunnel spillway. Many of these side-lines were run along the continental backbone to the rocky precipitous mass of the Pico Pinzon, which afforded an eyrie from which to spy out the physiography of the region. The result of all this was the determination of the feasibility of the Gamboa dam, and the location of the eight-mile tunnel spillway line to the Pacific, Mr. Ehle's exhaustive technical description of which will be found in a supplementary appendix at the end of this article.

When Major Black, in behalf of the Commission, took over from the new Panama Canal Company the work of building the Canal, in May, 1904, he found two archaic French excavators fitfully at work; and as the repair shops were either abandoned or dismantled, it was impossible to keep enough cars and engines in commission to handle even the dirt dug by these two machines. The working force had dwindled to something like 300 men, working 10 hours a day for a stipend of $1.20 in Columbian money—40 cents more than at the low ebb of the French *régime*. With the advent of the Americans, the day's wage mounted to $1.50 in silver. Since May, 1905, the Commission has paid $1.80 and $2.00. The efficiency of the laborer is never more than 30 per cent. of that of the Italian laborer in the United States.

CONSTRUCTION RAILROAD BRIDGE ON THE CHAGRES NEAR GAMBOA, OPPOSITE BAS OBISPO.

Built by the French Company, on steel piers, one of which has been washed out and replaced by wooden frame bents and a short suspension span.

Machine shops were opened at Matachin, and the excavating and traction machinery was overhauled. The excavators are of the endless-chain type, discharging twenty buckets per minute through a chute into 5-yard dump cars. Usually there are twelve cars to a train; on rainy days with wet rails the engines cannot haul more than four. During 1904, these excavators were found to work very well, in the easy digging, but the impression they made on the soil in comparison with the entire mass of earth to be handled, has been dubbed "hen scratches" by an unbiassed observer. The first of a lot of new and large steam excavators got to work in November, 1904. At this time the chief executive control was transferred from resident engineer Harper to division engineer W. E. Dauchy, formerly chief engineer of the Rock Island Railroad, a man of extended experience and executive ability. It might be remarked just here, that there appears little justification for the assertion that powerful railroads*



CULEBRA CUT, FROM THE NORTH END.

One of the old French excavators is seen in the foreground.

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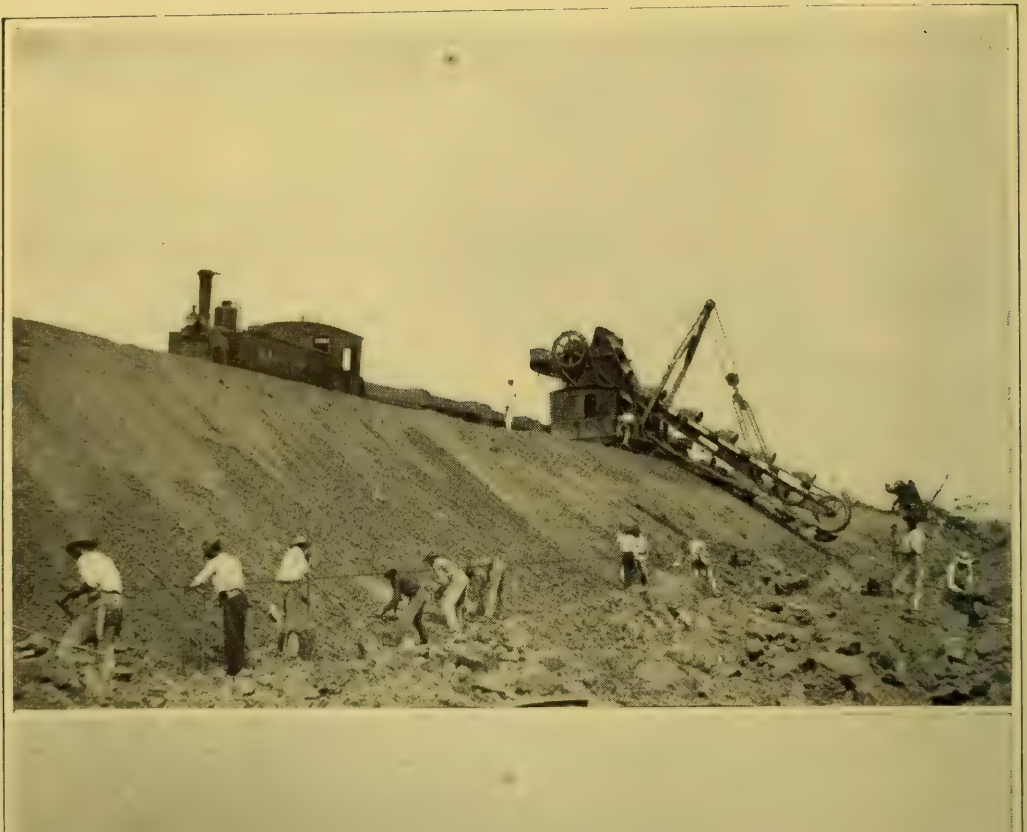
* Wallace, chief engineer; Dauchy, division engineer; Karner, resident engineer, had been more or less closely affiliated with railroads. Of the resident engineers, Ehle, Dose, List and Harper were from general, army, or city practice. Assistant engineers Nichols and Ruggles were from general practice. Quartermaster King is from the army; paymasters Toby and Shaefer are from the navy. Col. Gorgas and Major Lyster are from the army medical corps; Governor Magoon is from private life. Messrs. Ehle, Dose, and Nichols selected the members of the first engineering corps. After September, 1904, the selection was made by the Civil Service Commission.

have secured the appointment of railroad men to all the important positions at Panama. Two or three instances of railroad men being appointed, for their demonstrated engineering ability, do not warrant the sweeping deduction. It is, however, increasingly evident that enough army officers have been appointed to positions where engineering skill combined with infinite administrative tact is needed.

Mr. Dauchy, upon his appointment, did his expeditious best to forward the work of excavation and to determine the lowest yardage price, in order to afford the chief engineer a reliable basis for contracts, and for calculating ultimate expenditures. In the fall—the rainy season—of 1904, there were disastrous slides from Gold Hill, to the west of the Canal; the railway tracks were covered with clay, and work was necessarily suspended for more than a month. During the succeeding dry season, more shovels were put to work on the clay surface stratum, in the hope of avoiding a similar catastrophe in the rainy season of 1905. These shovels, 75- and 90-ton, the latter having a 5-yard bucket, made a good record in spite of inadequate traction and dumping facilities. The track was an unballasted, undrained makeshift, with sleepers of soft pine, and a slight rain sufficed to demoralize traffic. The high, narrow-base French rail was used, with 4-inch spikes; the insufficient length of the spikes was due to a failure to specify any particular length in ordering.

SOUTH END OF THE CULEBRA CUT.



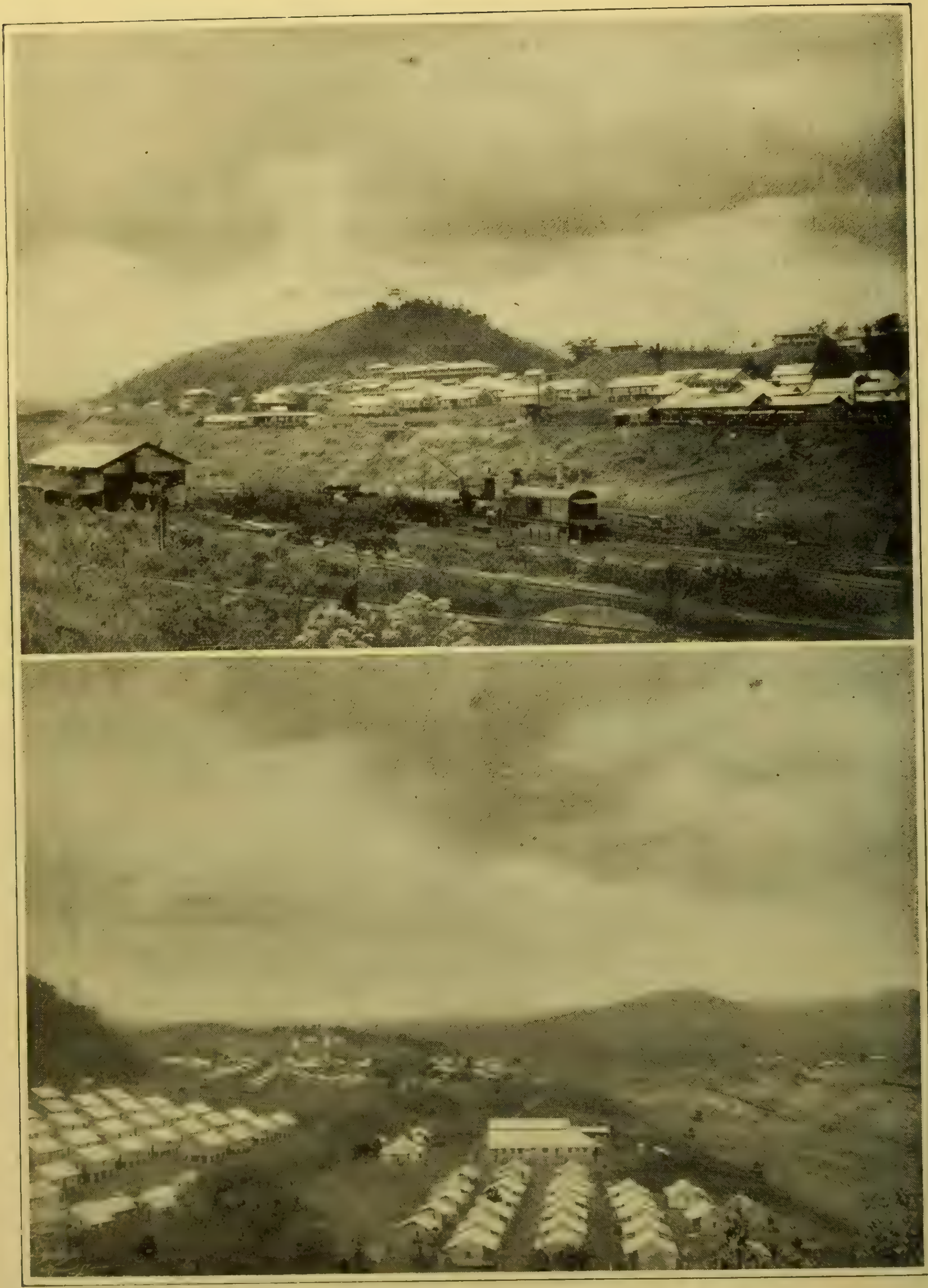
FRENCH EXCAVATORS AND AMERICAN STEAM SHOVELS AT WORK AT CULEBRA.

The upper picture shows the French chain-and-bucket machines Nos. 50 and 52; the lower shows the American shovels 101 and 102, in the 90-metre level.

The Belgian locomotives were ill-adapted to such a track, and sometimes, despite the frequent rail braces, sixty or seventy yards of rail would "turn turtle," derailing the excavating trains. Frequently the excavators had to shut down while the trains were jacked up and the track repaired, with bits of rail and scrap-iron in lieu of re-railing frogs and the heavy jacks which should have been provided. This sometimes took three days. "Probably the most serious detriment to progress," said one of the resident engineers to the writer, "was the delay, through red-tape, in getting equipment and supplies; for in spite of hurry orders, begging, and protests, no track tools, such as spikes, mauls, ratchet lining-bars, and track wrenches, were sent. Rails when cut could not be drilled for the bolts, and these half-bolted joints were the cause of many bad derailments. Men lining track had to go off and cut poles, or pick up old lining rods. Track jacks were scarce as hen's teeth. A few were resurrected from the French scrap piles and made serviceable for a while, but as they were badly rusted their life was short. Serious delays to the steam shovels working on rock faces at Culebra were caused by poor mining equipment. All that was available was inherited from the French, and was about at the limit of its effectiveness.

SHOVEL "NO. 201" AT THE BOTTOM OF THE CULEBRA CUT.

"Most of the work on the soft rock was done by the negroes with long juniper rods. Steam drills had to be used on the hard rock, but



GENERAL PANORAMA OF THE CULEBRA CUT, FROM OPPOSITE SIDES.

Both views show the camp. In the upper one a newly arrived shovel is seen in course of erection.

progress was very slow, and as it seemed impossible to get men to work at night, the steam shovel at a rock face was not very effective. The French had originally laid out their work in 5-metre benches, using the excavators, but for the steam shovel usually two of these were cut into one, so that the face was about 35 feet, except for the shovels on the top levels in clay, where it was often double the height.

"This overlying clay was full of springs, and often slid, burying the jack-arms of the shovels, but causing no serious trouble. At the bottom of the cut the French had left cross-over places, about every half-mile between the two sides of the cut, for their train-service. These had drainage openings through them and connected with the tunnel at the south end of the cut. This tunnel was built with iron-arched forms lagged with wood, and as this decayed it filled up so that the lower levels of this cut were drowned out and a fine lake was formed, cutting off all track communication, until it leaked away at a very slow rate with the coming of the dry season and less rain. In spite of this lesson, no attempt was made to provide against a repetition of the trouble in the wet season of 1905, until in May, when there was a feverish rush to cut the barrier at the south end. During the dry months from December, 1904, to May, 1905, everything was sacrificed to making a record for yardage and cost.

"For these months the cost as estimated was generally below 50 cents per yard. Such estimates were, however, largely a matter of book-keeping, and this fact had to be known to form any clear idea of the subject. With the coming of the wet season in May, yardage began to decrease and expenses increased so that the cost doubled. The large force was being rapidly increased, and the results decreased, until in July and August the work was practically at a standstill."

On his return from the Isthmus in August, Chairman Shonts of the Commission said that the digging had been stopped; General Hains and Mr. Ernst of the Commission are reported as saying there will be no further excavation for about a year. The halt has been called in order that the necessary preliminary work of sanitation may be done, similar to Colonel Waring's work at Havana; that malaria and yellow fever may be checked, if not abolished, by the eradication of the breeding-places of the mosquito; that an abundant supply of pure drinking water may be provided; that adequate shelter may be erected for the Canal employees. This is just what Mr. Morison said must be done in advance of any digging, and probably it will take at least the two years he postulated. It was a grave administrative mistake, therefore, to send to the Isthmus quantities of tools and equipment at this stage of the game, at the same time denying to the handful of men at work in the field the machinery and implements they imperatively needed.

It is often asked what proportion of the canal work has been done, but there has not yet been any decision as to the type of canal. However, the question may be answered in a general way. The total yardage excavated on the Panama Canal to date, of every character, is about 79,000,000 cubic yards. Much of this was thrown out by the present plans, and the new French Company admit that the Chagres has silted in 5,000,000 cubic yards, and the Rio Grande at the Pacific end 2,000,000. Also, much of the canal excavation was deposited too close to the cut, so that with the larger-sized canal now planned it has to be handled again.

Taking the Isthmian Canal Commission (1900-01) estimates of useful work as a basis up to 1902, the yardage of the present canal excavated would be in round numbers 41,000,000, so that for the various plans suggested the following approximate parts of the canal excavation are done:—

I. C. C. plan, 1901-2	about	28	per cent.
60-foot level plan, I. C. C., 1904	"	23	" "
30- " " " " "	"	19	" "
Sea-level " " "	"	16	" "

Of course this does not represent the whole work, since the dams, locks, breakwaters, etc., are not allowed for in the above percentages. Including these, the proportions would be about as follows:—

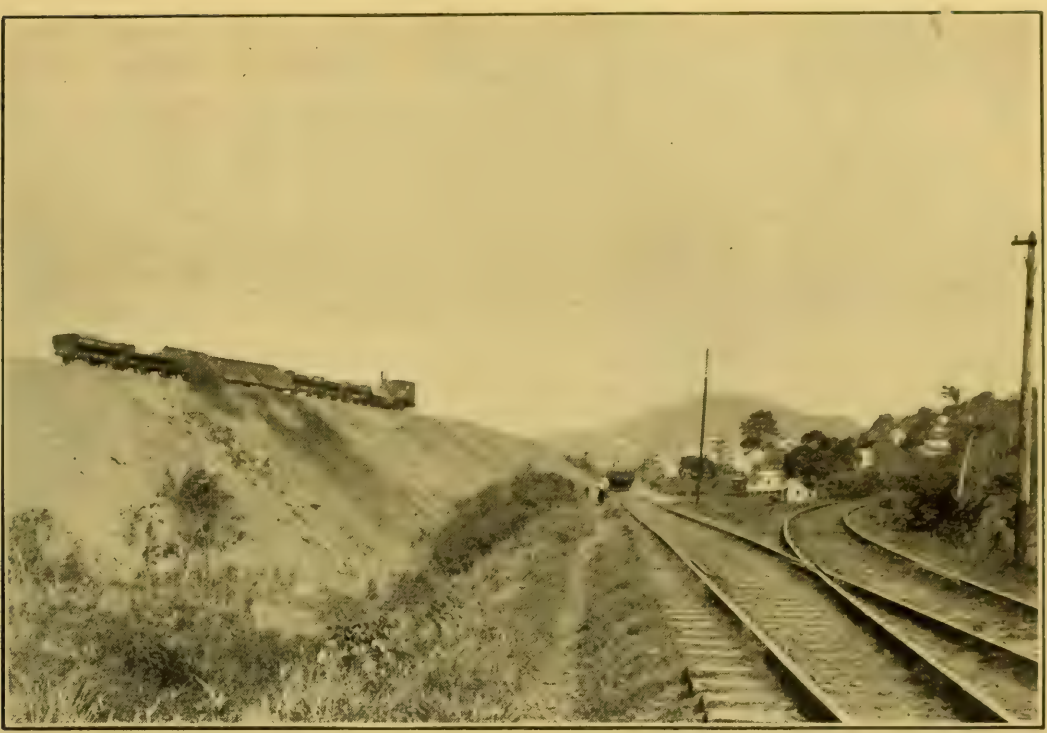
	Per cent.	
I. C. C. (80-foot level) plan, 1901-2	about 23½	(about 1/4)
" (60- " ") " 1904	" 16½	(" 1/6)
" (30- " ") " "	" 14½	(" 1/7)
" (sea- ") " "	" 13½	(" 1/8)

And this small percentage represents nearly a quarter of a century that the work has been nominally under construction.

The question naturally follows, when can the canal be completed? Chief Engineer Wallace, during his early experience on the Isthmus, estimated under the most favorable conditions:—

For sea-level plan	12	years.
" 30-foot level plan	10	"
" 60- " " "	8	"

This would be a fair estimate, for the work *could* be done in the United States under good contractors; but if we apply to this estimate



A HIGH SPOIL BANK NEAR CULEBRA.

The disposal of the material removed from the huge cut is a problem co-ordinate with that of excavation. The Gamboa dam, of which the data are given in the following Appendix drawn from Mr. Ehle's report, is there proposed as affording opportunity in its construction for disposing of a large part of the spoil.

the usual 50-per-cent. coefficient of inertia of tropical work due to labor and climate, that has been the fixed experience of many good engineers, it may be estimated with a certain measure of reliability that to complete the sea-level plan would take 16 years, the 30-foot level 15 years, the 60-foot level 12 years. The old French Company did well, excavating 70,000,000 yards, and the above number of years would be roughly at their best efficiency rate, which it will be difficult to beat, as they did mostly easy digging. A more accurate estimate, perhaps, would give: Sea-level, 15 years (until 1921); 30-foot level, 13½ years (until 1919½); 60-foot level, 12 years (until 1918). Of course with much red tape and bad management it may take longer. The sea-level plan (Wallace's estimate) will cost $230,475,725; the 30-foot level $194,213,406; the 60-foot level $178,013,406. The Isthmian Canal Commission report gives the cost of the 80-foot level plan at $144,233,000. It must be understood that as the work goes deeper it is more difficult to handle, on account of less accessible dumps, more troubles from water, and other causes.

APPENDIX.

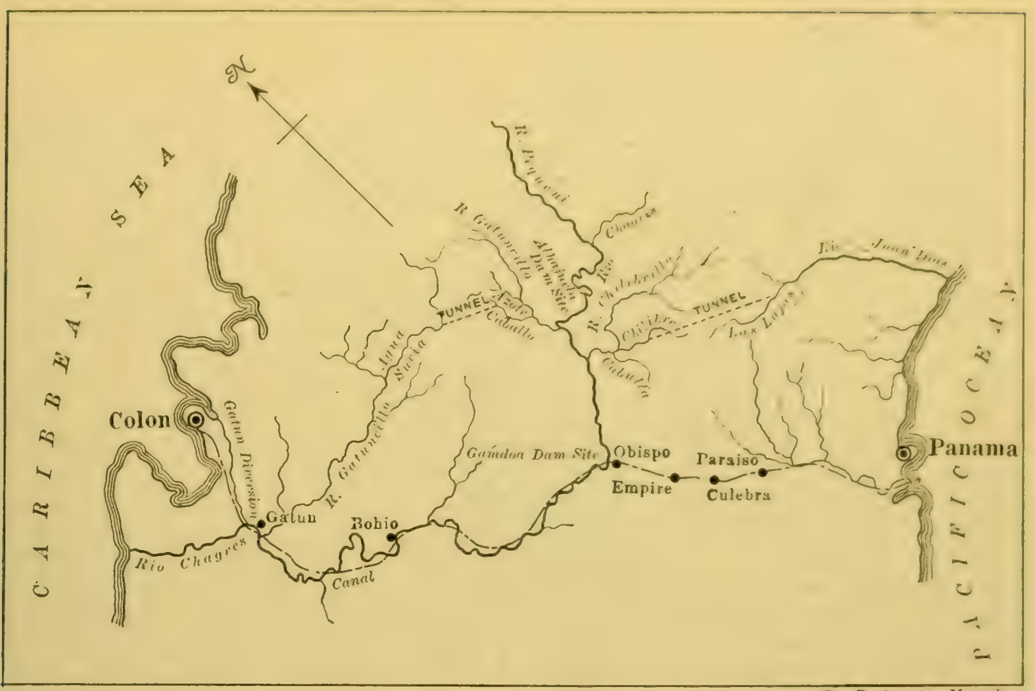
MR. EHLE'S ESTIMATES FOR THE GAMBOA DAM, AND THE TWO SPILLWAYS.

I. The Spillway Design.

The matter of diverging the Chagres floods above Gamboa has now been investigated quite thoroughly, and the data can now be assumed to introduce no considerable error in projecting the following structures.

In determining the location of the wasteway it may be of importance finally to make an adjustment between the cost of lowering the tunnel and raising the dam a unit, but on account of peculiar conditions for building the dam at Gamboa with cheap material from the Culebra cut, this would tend to give too great a height as a structure. There also enters as a factor in the problem the complex requirements for the floods, which are largely matters admitting of little refinement and requiring a considerable margin of safety, but nothing is gained by going beyond the limit in storage capacity, except for industrial uses. From the natural features it was decided that the limiting height for a dam at the Gamboa site should not exceed elevation 200 feet, and this design was used in connection with the preliminary scheme outlined in the September (1904) report with the incomplete data of that date. In this, the top of the tunnel was placed at elevation 175 feet, with the bottom at 145 feet, as the best adjustment to fit the conditions then known, giving a tunnel length of 41,000 feet (7¾ miles) for the Pacific and 23,000 feet (4 1/3 miles) through the Gatuncillo divide, using the Quebrancha location. Since then the surveys have shown that there is a much shorter location by the Azote Caballo branch of the upper Gatuncillo, giving a tunnel length of about 18,000 feet, and that it can be placed at a lower elevation, about 15 feet, without excessive additional cost. That is, the portal cut of the open excavation need not exceed 35 feet at the intake and run out in about half a mile, while at the outflow end in the Agua Sucia, the cut at the river need not exceed 30 feet. A location is now being made across this line. While the results are accurate enough from the preliminary surveys, there may be a variation of one per cent. in the tunnel length. Nothing can be definite about the character of the rock until after the borings, but the surface indications are favorable. In the hydraulic requirements for the discharge of the great floods, a concrete-lined tunnel has been designed with a segmental arch roof of 28 feet span with a rise of about ¼ and a clear height from the invert of 28 feet.

The hydraulic data are as follows:—Area 707 square feet, wetted perimeter 99.5 feet, hydraulic radius 7.1. From this section a tunnel discharging capacity and rate of flow is shown by a graphical chart at ordinary lake level (elev. 160 ft.) as 6,200 sec. feet, and after a raise similar to the 1879 flood (elev. 176.5 ft.) 10,200 sec. feet. These are computed from the formula $V = C\sqrt{RS}$, using the coefficient .012 in Kutter's formula as an average for the concrete lining and with a tunnel gradient .000435. This was designed as the smallest that could give a proper margin of safety in discharging the great floods when placed with the grade at elevation 147 feet and the top of the dam at elevation 200 feet. With the grade of this spillway at 132 feet, the maximum flood elevation would reach 176.5, or 23.5 feet below the crest of the dam, so that it would be possible to make a lower and therefore somewhat safer dam, or



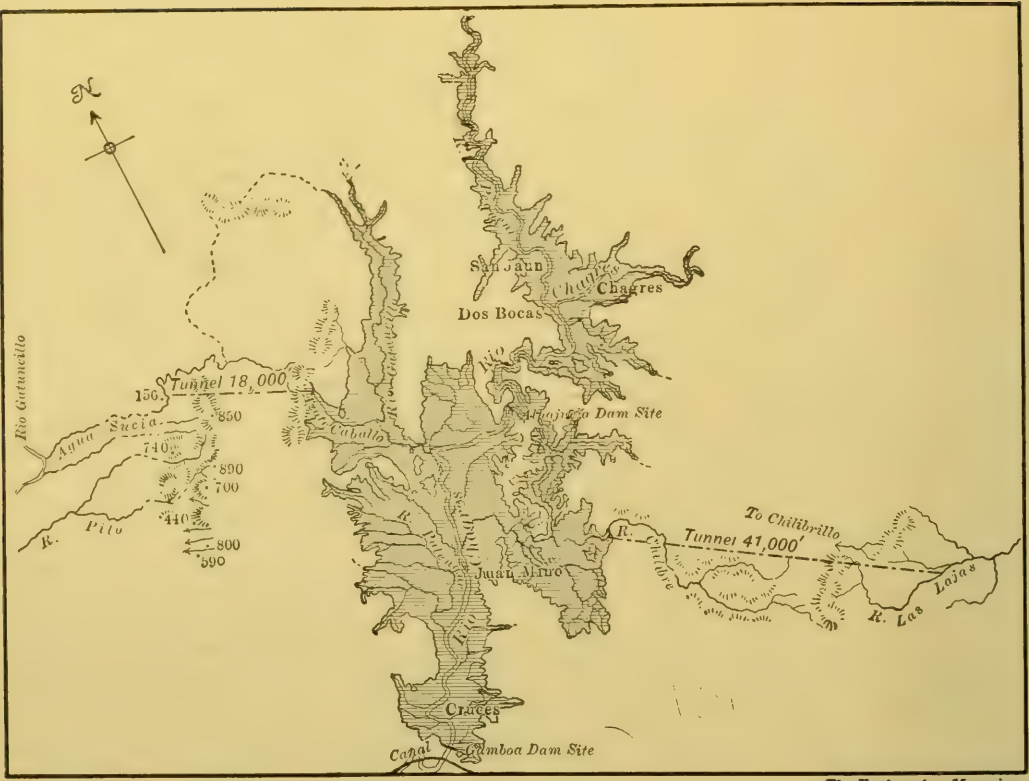
GENERAL MAP SHOWING WATERWAY SURVEYS IN RELATION TO THE PANAMA CANAL AND THE TWO OCEANS.

Scale 1 in. to 9 miles, very nearly.

there might be some saving in the open-cut excavation at the ends of the tunnel, although this enters with comparatively small weight as affecting the Gatuncillo location, and it would not be necessary to cut down to grade as the valleys at the portals are wide enough to carry off the discharge with a less cut at the portal.

The Gatuncillo site is very favorable for regulating works, which would probably be a combination of Stoney gates and valve openings at various levels in a gate house, so that the flow into the tunnel would be under complete control. If the almost impossible contingency, a cave-in in the tunnel, did occur in the wet season in a flood, it would be possible to cut off the flow and store in the reservoir and rely on the gates at the dam to handle the flow while workmen entered and made repairs. For the dam at elevation 200 feet, assuming the lake level safe at 8 feet lower, the storage capacity of the basin above elevation 176.5 at the end of the great flood to 192, or 15.5 feet, would be about 16,120,000,000 cubic feet, which would hold the very high rate of inflow, 11,000 sec. feet, of the wettest season, for about 23½ days with no assistance, except the overflow of 300 second feet of the power plant. As will be seen later on, abundant wasteway gates will be provided at the dam, so that no such necessity can occur. This will indicate the ample provision and resources that are possible in providing for extreme improbabilities.

While fixing the grade of the Gatuncillo tunnel for the portal at 132, or 15 feet lower than the scheme of the September (1904) report, does not materially affect the cost, it is not so favorable for the Pacific wasteway. It will increase the portal cut at the outflow to nearly 80 feet; or rather, lengthen the tunnel about ¼ of a mile, making a total length of 8 miles, and then it would take over 7,000 feet of open cut to get down the valley to the grade; for the



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MAP SHOWING AREA OF THE LAKE WHICH WOULD BE IMPOUNDED BY THE GAMBOA DAM, AND THE PROPOSED TUNNEL SPILLWAYS.

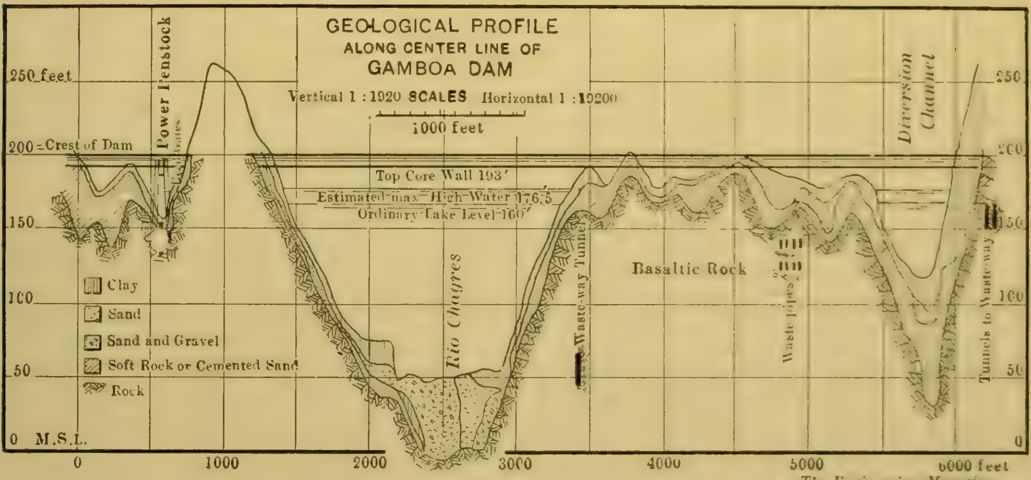
Lajas valley is quite flat at this point. At the intake portal on the Chilibre the change would not cause any noticeable increase in cost.

With the Gatuncillo wasteway, the water goes into the lower Gatuncillo drainage through the Agua Sucia branch, and this drainage will be diverted into Manzanillo Bay through a diversion channel now nearly completed by the French company. As the Gatuncillo wasteway discharge will require about 25 per cent. additional capacity in this channel, it is feared that the pro rata cost for capacity should be charged to the wasteway project. What completetion of the work may cost can only be guessed at, as the data are not yet available, but $1,000,000 may cover it, and of this $250,000, or 25 per cent., is charged to the wasteway for comparison purposes. The channel is purely dredge work, starting from the village of lower Gatun. The lower Gatuncillo has a wide valley for a considerable distance up stream, so that it will not be much affected by the additional water spilled into it, not as a flood but as a steady flow, probably never exceeding 10,000 second feet and generally much less.

In constructing the wasteway, it would be necessary to make some roads for carting in tools and supplies, and some temporary dams might be put in the Gatuncillo to make ponds in low water, but the Chagres is navigable at all times with canoes. It might also be possible to arrange the work so that the back water from the dam would be available. No special charge has been made for these items, as they are small and covered by the contingency percentage.

II. The Gamboa Dam.

This should be a reservoir dam, on account of the natural conditions, nearness to the canal, and economy of time and cost. The design that seems most advisable to submit has an elevation of 200 feet at crest, which may be a trifle higher than necessary, as it gives a freeboard of 23.5 feet with the greatest flood; and an estimate has been made for the crest elevation 185 feet, giving a freeboard of 8.5 feet or about the usual amount. The difference in cost is about one half million dollars, but probably it would be as well to pay the difference as an insurance for a safer dam. There is so much available cheap material for embankment that it probably will be decided to make a greater fill than indicated by the neat lines shown for the section, which has a crest width of 20 feet and a slope 1 on 2, with a core wall founded in rock 30 feet wide up to elevation 70 feet and then sloping 1 on 10 to 5 feet at the top, elevation 193 feet. The embankment is to be made from the débris of the Culebra cut, dumped from trestles or aërial cableways as are best adapted. It probably will not be necessary to make any special provision for paving, as the larger pieces of quarried rock can serve for this. As one of the difficulties of the great excavation is sufficient and convenient dumps, it is taken that the charge for material would be nominal, mostly due to the cost of dumping, with perhaps a percentage of the transportation charges. The total average per yard need not exceed five cents.



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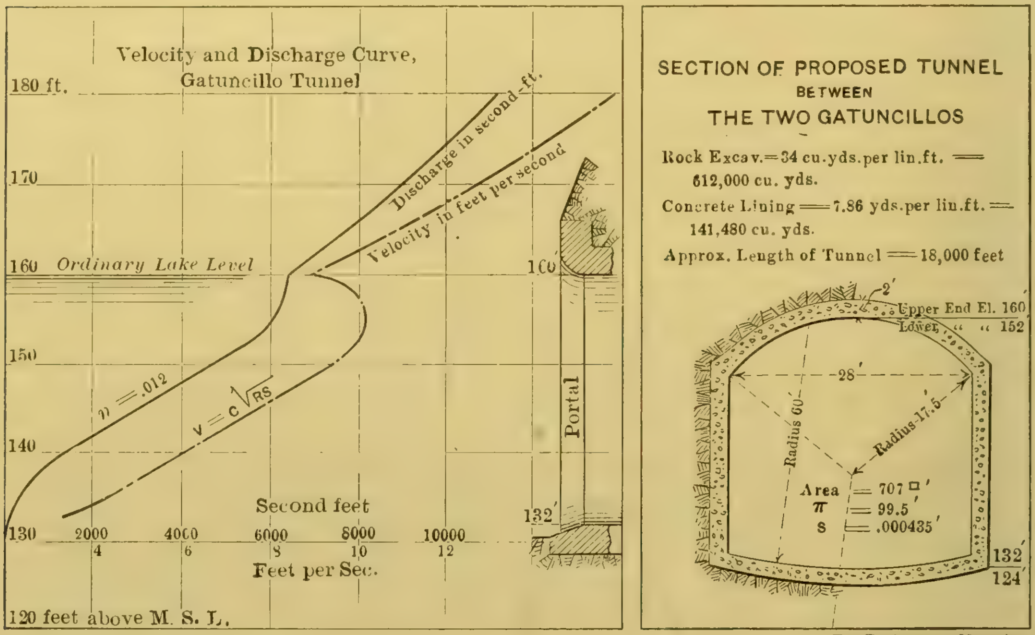
GEOLOGICAL PROFILE ALONG CENTER LINE OF GAMBOA DAM.

From the data now available it does not appear that any exceptional difficulties need be apprehended in construction, as the site is well adapted for such work and the maximum depth to rock is about 52 feet below low water. The core wall construction can probably be built in coffer dam by sections with little difficulty. It was assumed that the core wall would have foundation 10 feet below the surface of the material noted as soft rock on the profile and that probably would be leveled with light cutting in the hard basaltic rock.

In the dam at the saddle at the South end, have been placed the head gates of a power plant with tunnel intakes at various elevations. In the hill which forms the north buttress of the main dam, is placed the gate tower for emptying the reservoir with low tunnel intake, placed with two gates each at elevation 44 feet, 75 feet, and 100 feet. From the wall a large tunnel goes through the solid rock to below the toe of the dam.

At a point farther along the dam and near the old spillway are placed waste pipes at elevation 132 and 142 feet, of a total capacity equal to the tunnel wasteway and, in connection with the tunnel and weir on the north end of the dam; to do its work, if the very improbable cave-in should occur during the flood season. In the spillway is placed a dam for making a lake at about elevation 125 feet, to act as a cushion to take up as much as possible the effect of dropping the water 50 or 60 feet to this level. A gate house is provided for the pipes on the north side of the ridge near the pond, and the pipes are designed to have about 25-feet back pressure, by discharging upward to facilitate opening the gates and also to have a vertical fall of the water.



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SECTION OF PROPOSED GATUNCILLO SPILLWAY TUNNEL, WITH VELOCITY AND DISCHARGE CURVE.

The tunnel and weir in the hill at the north end of the spillway is designed for Stoney gates with sill at elevation 150 feet. The weir is to discharge along the side of the channel in a thin sheet of water down into the pond. The toe of the dam at the pond is to be protected by a concrete wall.

The dam that makes the pond is to be a concrete weir, and there is also an opportunity to make a similar shorter weir by excavating a channel in the creek that discharges into the Chagres near the toe of the main dam; but this water would come more directly to the canal. After the water flows over the weir it would pass down to the diversion channel along the Canal, and it may be advisable to place some weirs below to check the current. Their cost would be but a small percentage of the total for the whole project, and comes properly under diversion channels, as the water is then clear at the dam. It is to be noted that the dam now submitted is not on the same location as that of the September (1904) report, but is swung down stream at the north end of the river crossing, to take advantage of the narrowing in the rock channel, a shorter distance below the first site, as shown by the later borings.

Estimate of Gatuncillo Spillway.

612,000 cu. yds. rock excavation in tunnel @ $4.00	$2,448,000
141,480 cu. yds. concrete lining @ $10.00	1,414,800
500 linear feet of shaft @ $50.00	25,000
190,000 cu. yds. rock excavation @ $1.15	218,500
50,000 cu. yds. earth excavation @ $0.50	25,000
Controlling works at intake (about)	40,020
Proportion in diversion channel at lower Gatun to Manzanillo Bay	250,000
Total (about)	$4,421,320

Estimate of Pacific Spillway.

1,436,160 cu. yds. rock excavation in tunnel @ $4.00	$5,744,640
332,000 cu. yds. concrete lining @ $10.00	3,320,000
500 linear feet of shaft @ $50.00	25,000
300,000 cu. yds. rock excavation @ $1.15	345,000
Controlling works at intake (about)	55,360
Total (about)	$9,490,000

Estimate Gamboa Dam.

Crest at 200 feet elevation, length on crest about 5,700 feet:—	
2,700,500 cubic yards embankment @ $00.05	$135,025
259,400 cubic yards concrete @ $8.00	2,075,200
Excavation for core wall:—	
104,300 cubic yards earth excavation below river level @ $1.00	104,300
90,000 cubic yards earth excavation @ 0.75	67,500
28,600 cubic yards rock excavation (mostly soft rock) @ $1.25	35,750
	$2,417,775
Difference for Dam at elevation 185 feet, length on crest about 4,230 feet.	
648,000 less cubic yards embankment @ $00.05	$32,400
65,900 " " " core wall @ $8.00	527,200
19,000 " " " earth excavation @ $00.75	14,250
6,000 " " " rock " @ $1.25	7,500
	$581,350
Cost of Dam at elevation 185 feet	$1,836,425

If we add 20 per cent. for engineering work and contingencies, the estimate would be,

For the dam at elevation 200 feet	$2,901,330
For the dam at elevation 185 feet	$2,203,710

"It is noted for comparison, that Mr. George S. Morison, past president of the American Society of Civil Engineers and member of the Isthmian Canal Commission of 1899-1900, in a paper in the Transactions American Society of Civil Engineers, gives the cost of the Alhajuela Dam at $3,000,000 plus 20 per cent., or $3,600,000, and that General Abbot's translation of the report of the New French Company gives $2,356,700 plus railroad $312,100, plus proportion of contingencies $36,800, plus $7,600, or a total of about $2,713,200."

THE UTILISATION OF LOW-GRADE FUELS FOR STEAM GENERATION.

By W. Francis Goodrich.

The leading idea in modern industry is the reduction of the cost of production, by the closest study of materials, methods, appliances, and labor. In the steam-generating plant, the chief aim is the economical production of power, and the "raw material" to be studied at the outset is the fuel. Mr. Goodrich therefore begins his study of the problem at its very foundation. The supply of low-grade fuel and its cost necessarily vary considerably in different localities. Mr. Goodrich's study is based upon conditions existing in London, but his deductions may readily be applied or his methods adapted to the situation at other places.—THE EDITORS.

IT is on record that James Watt had a decided preference for the very best fuel procurable, and that on more than one occasion he expressed the opinion that the best fuel was the cheapest in the end, no matter what the price might be.

There can be no doubt that under the conditions obtaining in the early days of steam generation, the opinion expressed by James Watt and others was perfectly logical. The combustion process, even now but imperfectly understood, was at that time a matter of no interest whatever; but now, eighty-six years after James Watt has been laid to rest, it ill becomes the steam user to re-echo his opinion; indeed, nothing could more strikingly illustrate the appalling ignorance which is only too prevalent among steam users at this time.

The life-long labor of Watt was essentially devoted to steam *utilisation,* and not to steam *generation.* When one recalls the great work accomplished by this remarkable Scotsman—his ceaseless industry and dauntless perseverance—it may be well understood why he devoted comparatively little attention to steam generation. Had Watt directed his attention to steam generation rather than its utilisation, the world would have been the poorer today, and it is impossible to realise what the effect would have been upon commercial development.

Even as the steam user of today frequently expresses the same opinion as is attributed to James Watt, so does he to a very large extent follow Watt in devoting an almost undivided attention to the engine; and so we find everywhere large works equipped with the finest engines obtainable, the boiler house to a large extent being neglected. While the manufacturer is leaving nothing undone in the economic utilisation of the steam, he too often neglects the fountain head—the boiler house. Here, where economy should commence, it is unknown, and the unscientific steam user fails to recognise that the loss in the generation of steam is added loss, which cannot possibly be recouped at any later stage in the manufacturing process, no matter what the particular industry may be.

Those who are intimately acquainted with steam-raising practice in Great Britain (and no doubt elsewhere) will be well aware that this is not overdrawn; the grievous lack of attention given to economy in steam generation has undoubtedly been a serious factor operating against the manufacturer. In the grim commercial struggle, fuel economy is an element which cannot be disregarded, and those who have devoted but little attention to the stoke-hole have often been hard put to it in competition with others who have recognised the wisdom of beginning at the beginning.

In many manufacturing industries it is becoming increasingly evident that the fuel cost is *the* factor which must receive close attention; indeed, in some it may be said to be the vital factor in the cost of production. Those who have achieved the greatest success in every manufacturing industry in which steam is used, are those who have reduced their works administration to the same basis as that obtaining in the central station. The really successful paper maker is he who is able to make each ton of paper at the minimum fuel cost. The wide-awake dyer strives to dye each piece of material at the lowest fuel cost, and so on through each manufacturing industry.

To utilise steam economically as a means to an end is not sufficient in itself, although it has undoubtedly been beneficial even when the boiler house has been neglected. The up-to-date manufacturer will go further than this; he will begin at the right end, putting both steam generation and utilisation upon the most efficient basis, and having done this he has accomplished not a little towards equipping himself for successful competition.

When the manufacturer has reduced his production cost to the minimum he has done his part, and collectively a great deal would thus be accomplished. I do not suggest that every dead industry would be revived, or that every languishing industry would flourish; much might still remain to be done; but having helped himself, the steam user might then reasonably look for help.

Why legislate for those who have not and will not help themselves? Why protect those who to a large extent have failed to compete because they have been content to conduct their works as their forebears did? We have many such as these in the country; to legislate for their benefit may restore some of them to their erstwhile prosperous state, but from a National standpoint such assistance is to be deplored.

The main object of this article is to show (1) that the utilisation of low-grade fuels does materially reduce the cost of steam generation, and accordingly the cost of production; and (2) how such low-grade and cheap fuels may be best utilised for steam generation.

Taking the whole of the circumstances into consideration, is it economical to burn cheap or low-grade fuels, or does the opinion expressed by James Watt over a century since still hold good?

It must be borne in mind that when Watt commenced to use steam in Cornwall—and in fact, during the whole of the time that he labored in the "Delectable Duchy"—ordinary natural-draught boiler furnaces of the crudest description were used. Watt was content even without a fire door, the mouth of the furnace being closed by merely heaping up coal on the deadplate, there to lie until pushed forward when recharging the furnace.

It is easy to understand why the best fuel was the cheapest at this time; indeed, there was no choice; nothing but the best fuel could be burned under the conditions then obtaining. From this time forward, and even until a period only about thirty years since, little attention was devoted to fuel economy.

Whether it is economical to burn cheap or low-grade fuels depends entirely upon certain specific conditions which we will briefly discuss.

(1) The cost of good steam coal, and its calorific value.

(2) The comparative cost of small and lower-grade fuels and their calorific values.

(3) Whether or not the cheaper fuels are burned under such conditions as will ensure that the full calorific value of the cheaper fuel shall be realised.

For purposes of argument, we will assume that the best Welsh steam coal, having an average calorific value of 14,500 British thermal units, can be obtained in London at about 21 shillings per ton delivered. Then for purposes of comparison I would set against this a bituminous slack fuel costing about 12 shillings 6 pence per ton delivered, and having a calorific value of 12,500 British thermal units. London is selected purposely because the freight charges on any fuel are high and because it has been frequently urged that with this factor in mind it does not pay to burn "so-called cheap fuels" in London.

Without entering into any calculation, mysterious or otherwise, it must be evident to anyone that the extra weight of bituminous slack which must be burned in order to evaporate the same weight of water as is possible with the Welsh coal is very materially less than the comparative cost of the two fuels.

About a year since I conducted an evaporative test in London with a bituminous slack fuel having a calorific value of 13,007 British thermal units, costing 12 shillings per ton delivered, the average evaporation over the whole week being 8.82 pounds of water per pound of fuel burned from and at 212 degrees F.

In comparing the actual evaporative efficiency of this fuel with its theoretical thermal value, it will be evident that the results obtained were by no means the best results possible; but it must be borne in mind that the evaporative efficiency given is the average for 168 hours' work, under varying conditions, with several extended periods of very light work. The result quoted was obtained with hand-fired forced-draught furnaces fitted to a large marine-type boiler.

As the result of many experiments the late Mr. Bryan Donkin, M. I. C. E., published the following comparative figures some years since:

Kind of Fuel.	Cost of Fuel per ton.		Water evaporated per lb. of fuel.	Cost of Fuel per 1,000 gallons of water evaporated.	
	s.	d.	lbs.	s.	d.
A. Dust coke	5.	0	6	3.	8
B. Dust (Welsh coal)......	10.	0	8	5.	3
C. Large Welsh coal.......	22.	0	9	10.	11

Those who are intimate with steam-raising practice will be well aware that these figures have been verified again and again over extended periods and under a great variety of working conditions. It may further be submitted that the fuel costs in each case err on the right side. In some large cities, where all coke dust is sold separately at the gas works, this fuel may be obtained at 1 shilling per ton at the works. In South Wales it is also possible to obtain large quantities of dust fuel from Welsh steam coal at from 1 shilling to 2 shillings per ton. A sample of this fuel taken at random and tested was submitted by the writer to the Royal Commission on Coal Supplies; its calorific value was actually 13,646 British thermal units.

It is a common delusion that a small fuel must necessarily be of low calorific value, and accordingly of doubtful economic value even if it can be burned. As a matter of fact, many small fuels are of excellent calorific value and when burned with suitable appliances will show a phenomenal saving.

Again and again have I seen an evaporation of 10 pounds of water per pound of fuel obtained with slack from Welsh steam coal costing from 5 to 6 shillings per ton less than the large coal. Slack from a good Welsh steam coal is really remarkable value for money as compared with the large coal from which it is separated; generally speaking, 20 tons of such slack will evaporate fully as much water as 19 tons of the large coal, and assuming their respective costs per ton to be 15 shillings and 20 shillings, the saving to the steam user will be the difference in cost between 20 tons at 15 shillings per ton and 19 tons at 20 shillings per ton, say £4.

If we compare an average bituminous slack with an average Welsh steam coal, we get the following result, assuming a calorific value of 7½ pounds of water per pound of fuel for the bituminous slack, and 10 pounds of water per pound of fuel for the Welsh steam coal, their costs respectively being 12 shillings and 20 shillings per ton delivered:—

In order to evaporate the same quantity of water as could be evaporated with 20 tons of Welsh coal, costing £20, 25 tons of bituminous slack at 12 shillings per ton must be burned, costing £15, thus effecting a saving of £5.

These are but fair average examples, and are not overdrawn; they represent what has actually been done in London in scores of cases, and may therefore be accepted as authentic.

It is quite true that other factors have to be taken into account in order to arrive at the *net* economy which can be effected. It may be suggested by the incredulous, for instance, that the extra weight of slack to be burned would necessitate the employment of another fireman at 30 shillings per week; but the wide-awake steam user would offer his firemen a bonus of, say, 2 shillings per man per week; this always has the desired result. Give the firemen a definite interest in the way of some financial encouragement, and no difficulty is presented. On the other hand, if you fail to give those who handle the fuel some direct encouragement it is more than likely that you will fail to secure the economy which you should secure, and like many another steam user you will condemn small cheap fuel as a delusion and a snare.

In many cases where small fuel is burned it is not an easy matter to get rid of the incombustible, and sometimes as much as 2 shillings per ton is paid for its removal. The steam user who believes in burning the very best fuel obtainable fastens upon this as a powerful argument against the use of cheap fuel; he gravely observes that cheap slack is half rubbish, and that half of it has accordingly to be carted away.

Such a statement as this is by no means uncommon; indeed, it is heard frequently. Needless to add, the man who seriously puts this forward as an objection to the burning of a cheap small fuel is grossly ignorant and knows little or nothing concerning the composition of fuels. This is the type of steam user who has never helped himself, and is never likely to. In the stress of competition, should the State not help him by favorable legislation, while he may lose everything else he will still keep his opinion.

Generally speaking, the percentage of incombustible in bituminous slack and small rough fuels is not high, varying from about 20 per cent. to 9 per cent., according to the price. Reasonable uniformity in calorific value and in the percentage of incombustible matter can be ensured only by buying fuel on analysis, and by systematic testing and analysis of the fuel delivered so that any serious decrease in the calorific value or increase in the percentage of incombustible may at once be detected.

Neither the colliery proprietor nor the coal merchant is particularly anxious to sell fuel on analysis, nor is this to be wondered at. To buy fuel on analysis is to demand from the vendor definite value for money; this the purchaser has a perfect right to do, and the time is rapidly coming when this system of buying fuel will be more or less generally adopted. Those who conduct their works on these lines possess very definite opinions as to the economic value of cheap and low-grade fuels. The scientific application which they have given to the stoke-hole has been profitable to an extent which can be realised only by those who are intimate with modern practice in economic steam generation.

There can be no doubt that the useful and extensive experience which has been gained in the combustion of town's refuse has clearly demonstrated the possibilities of steam generation from the lowest grades of colliery waste. The following table is of interest as showing the composition of several waste fuels, most of which are now being successfully burned for steam generation. I have extracted this table from the minutes of evidence which I gave before the Royal Commissison on Coal Supplies.*

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* See Second Report of the Royal Commission on Coal Supplies, 1904, pages 272-278.

TABLE SHOWING ANALYSES OF CERTAIN INFERIOR FUELS.

		Calorific Value.	Volatile Matter. Per cent.	Incombustible. Per cent.	Moisture. Per cent.
Park Coal Co., Mirfield.	Coke dust and coal dust.	10.2	22.96	22.23	....
Nunnery Colliery Co., Sheffield.	Pond settlings from tip.	10.3	27.43	16.06	....
Low Moor Co., Ltd., Bradford.	Tank settlings.	5.75	20.63	20.66	10.5
Aldwarke Main Colliery, Rotherham.	Pickings.	10.8	35.5	24.066	....
Morley Main Colliery Co.	Bottom hub.	7.1	41.6	42.0	....
Nunnery Colliery Co., Sheffield.	Pickings from screens.	8.5	24.075	36.6	....
Nunnery Colliery Co., Sheffield.	Coal washery refuse.	5.1	17.125	54.66	....
Nunnery Colliery Co., Sheffield.	Pickings.	13.0	35.16	9.23	....
Fryston Colliery Co.	Fine washings.	8.19	39.36	38.9	....
New Charlston Colliery, Normanton.	Washery refuse.	10.28	.....	11.3	11.4
New Charlston Colliery, Normanton.	Pond settlings.	12.04	.....	0.78	40.2
Woolley Colliery Co.	Pond settlings.	11.66	21.125	17.4	....
Crawshaw & Warburton, Dewsbury.	Shale.	4.45	27.03	56.63	....
Neepsend Gas Works, Sheffield.	Fine coke dust.	9.4	4.3	13.5	....

It may be of interest to record what has been done with the last-named fuel in the table, viz., fine coke dust (from Neepsend Gas works, Sheffield) as it affords a striking object lesson on the utilisation of a low grade fuel with forced-draught furnaces.

In the boiler house of the Sheffield *Daily Telegraph,* before experimenting with the coke dust referred to in the appended table, 45 tons of coal was burned per week at 12 shillings 6 pence per ton, totalling £28 2. 6. weekly. Seven loads of incombustible had to be carted away at a cost of 2 shillings per load, a total cost of £28 16. 6. One Lancashire boiler only out of two such boilers was used, the dimensions of the boiler being 24 feet by 8 feet, and much trouble was experienced in preventing smoke.

Having arranged for a supply of the coke dust already referred to in the table, Meldrum forced-draught furnaces were fitted to two Lancashire boilers with the following remarkable reduction in the fuel cost.

Per week.	£.	s.	d.
Six tons of coal at 9 shillings 3 pence	2.	15.	6.
Coke dust	3.	4.	0.
Two extra stokers	2.	12.	0.
Flue cleaning	..	10.	0.
Twelve loads of incombustible	1.	4.	0.
	£10.	5.	6.

With an increased demand for steam, the weekly item for coal increased to £5 3. 2.; and having to work the two Lancashire boilers together in order to burn the requisite quantity of coke dust, it was at length decided to instal a Stirling water-tube boiler with a large grate area, equipped with forced-draught furnaces and patent divided ashpits.

The figures here quoted are extracted from the *Engineer*, January 13, 1905, page 49.

This is a remarkable object lesson in the utilisation of a low-grade fuel, but it is by no means an isolated example. I call to mind many similar cases in Glasgow, some years ago, when the Corporation Gas Department disposed of large quantities of excellent coke breeze at 1 shilling per ton at the gas works. A considerable number of steam users were unable to arrange for regular supplies sufficient to meet their requirements, and cases where a saving in fuel cost of from 50 per cent. to 75 per cent. was effected were quite common.

It is only in large gas works that any considerable surplus of coke breeze is available, and during the past few years (more particularly in London) the price of this fuel has become so high that it is open to serious question whether, considered on the basis of calorific value, it will compare at all favourably with a small bituminous slack fuel.

With coke breeze costing from 8 to 9 shillings per ton delivered, having a calorific value of from 8,000 to 9,500 British thermal units, and a slack fuel costing from 10 shillings 6 pence to 12 shillings 6 pence delivered, possessing a calorific value of from 10,500 to 13,000 British thermal units, all factors being considered, the latter is likely to be the more valuable fuel.

While 1 shilling per ton at the gas works is a ridiculously low price for a coke breeze of fair calorific value, yet is equally true that the price now ruling in London is out of all proportion to the calorific value of the fuel. So far as I have observed, the coke breeze now offering in London varies very considerably in calorific value, and those who have this fuel to dispose of would do well to moderate their prices, or a slump will surely come sooner or later, when the steam user will reap at any rate a temporary harvest.

Pan breeze, which frequently contains 50 per cent. of incombustible, would not appear to be a very promising fuel; but it is nevertheless successfully employed in many gas works for steam generation. It would be idle to pretend that the firemen prefer this fuel to coke, but by treating the men reasonably it is quite possible to burn it when the steam requirements are not excessive.

In the average gas works it is of importance so to utilise the pan breeze and the poorest of the coke breeze, such a course having the effect of leaving free for sale the entire output of coke and practically the whole of the coke breeze produced.

What this means in the economic administration of gas works is clearly evidenced by their universal prosperity, and the practice of utilising the very poorest and unsaleable fuels for power production where they are produced is an object lesson which might be studied with advantage by many collieries.

The utilisation of these low-grade fuels in gas works has been effected by the installation of forced-draught furnaces, and there are now but comparatively few gas works where such furnaces are not in use.

Needless to add the steam requirements in the average gas works are not severe, or it would not be possible, without multiplying the number of boilers, to use such a fuel as pan breeze with internally fired boilers. The consideration of the type of furnace best employed in the combustion of this and other low-grade fuels, and of the possible utilisation of shale, town refuse, and similar lowly and little appreciated supplies of combustible, is, however, of necessity deferred until a following article.

THE VARIOUS METHODS OF GOVERNING FOUR-CYCLE GAS ENGINES.

By R. Mathot.

The constantly increasing use of the internal-combustion motor, in the very largest as well as small and medium sizes, makes it unnecessary to point out further the interest and importance of Mr. Mathot's subject. He is one of the leading experts in this field on the Continent, and the author of several standard treatises on gas-engine design, construction, and operation.—THE EDITORS.

WHATEVER may be the arrangement of the parts of a gas-engine, the dimensions of the latter are calculated so that a maximum moving force can be realized, on the supposition that each one of the valves admits the necessary quantity of gas or air to produce a homogeneous mixture which is capable of giving, by its explosion and expansion, the greatest possible mean pressure on the piston.

This mean pressure is quite variable and depends on the type of machine, the kind and time of ignition, the proportions and elements of the mixture, and finally on the calorific power of the gas used.

It varies generally between 4.5 and 5.5 kilogrammes per square centimetre (60-80 pounds per square inch) for engines using poor gas, and between 5.5 and 7 kilogrammes per square centimetre (80-100 pounds per square inch) for engines using city gas. I have however met cases in which the mean pressure reached 6-6.5 kilogrammes per square centimetre (85-92.5 pounds per square inch) with poor gas and 7.5-8 kilogrammes per square centimetre (107-114 pounds per square inch) with city gas.

When an explosion occurs at each cycle, the engine whose piston is put into motion by the mean pressure mentioned realizes its maximum power. If the work absorbed by the machines that are run by the engine corresponds exactly to the power of the latter, its speed will not tend to accelerate. But if, on the contrary, the resistance of the machines diminishes and the power developed by the engine is no longer exactly counterbalanced by an equivalent load, the speed tends to increase. At this point the governor intervenes and modifies the speed conditions of the engine, so as to maintain it within the normal speed limits.

We propose now to examine the modes of action of the various governors most generally used to regulate internal-combustion engines.

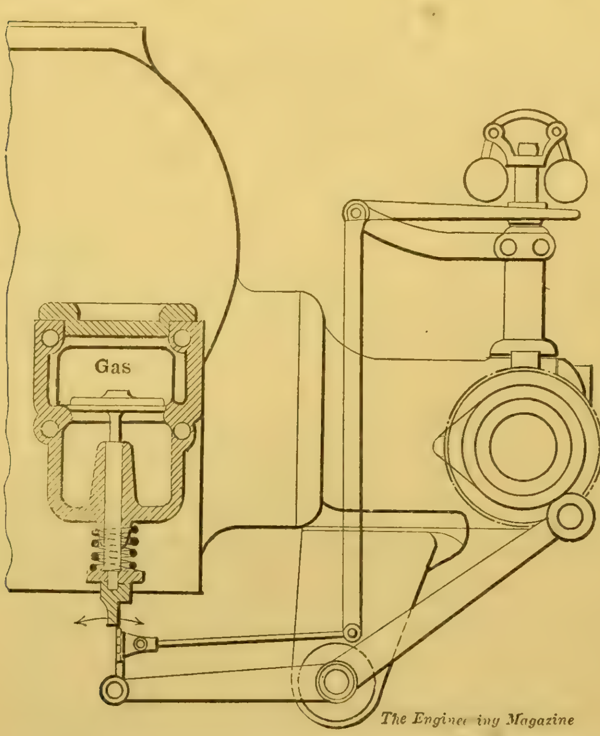

FIG. I. CENTRIFUGAL GOVERNOR, HIT-OR-MISS TYPE.

The first designers had observed that the practical limits between which the proportions of gas and air in a mixture could be varied, so as still to obtain ignition, were rather narrow; the more so, as the engines operated at relatively low pressures. Also the attempts that were made at the outset to employ contrivances by means of which the proportions could be varied, did not have great success. Moreover, proceeding in this mode, a quite noticeable increase in the gas consumption was very soon observed. Hence it was quite natural to search for a combination by means of which the gas could be completely cut off at a given moment and so cause a "miss." The governing system obtained thus was called "hit-and-miss" regulation. In this system the opening of the gas inlet valve depends on the action of the governor, while the air admission

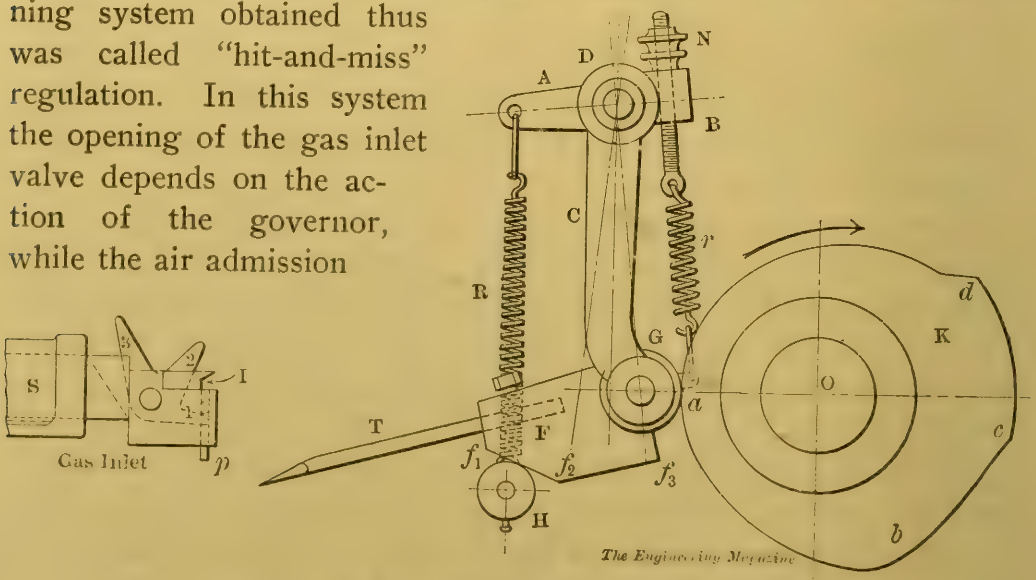

FIG. 2. INERTIA GOVERNOR, HIT-AND-MISS TYPE.

remains independent and occurs at each cycle. As a consequence the number of admissions of the mixture, and therefore the number of explosions, varies as the work of the engine, while the value or composition of each charge admitted, as well as the compression itself, remains constant.

This procedure thus furnishes the possibility of governing, once for all, the quality of the mixture and the conditions under which it acts in the cylinder, so as to obtain the maximum useful work, even if the engine is not working under full load. This method of governing has been for many years considered the most economical.

As shown on page 356, the function of the governor is to displace a light piece which is inserted between the support of the gas inlet valve and the cam. The opening or non-opening of the valve depends on the interposition or non-interposition of this piece. The governor, having no work to overcome, may be a very small and unobstructive piece of apparatus. The small motion of its moving parts causes but little wear and assures perfect isochronism.

This system of admitting by hit-and-miss carries with it the inconvenience of the "misses"—that is, under the action of the regulator several cycles may succeed each other without explosions. This inconvenience would show itself immediately by a retardation of the speed of the engine, if the precaution were not taken of providing it with a very heavy flywheel, or one of great diameter, which during the "misses" restores the surplus energy accumulated during the explosions.

The great weight of these flywheels evidently reduces the mechanical output of the engine, and the difference in output between engines having normal flywheels and those having extra heavy ones may be estimated at about from 3 to 5 per cent.

The use of extra heavy flywheels must, in my opinion, be considered rather as a subterfuge than as a mechanical means to remedy the difficulty, and experience seems to demonstrate that there might be a certain danger in using heavy flywheels, when the power of the engine passes a certain limit. In fact, with hit-and-miss regulation, there will occur after several "misses," a powerful explosion corresponding to a pressure of 30 to 35 kilogrammes per square centimetre (430-500 pounds per square inch) on the piston. This pressure is transmitted to the crankshaft and to the flywheel whose speed has diminished on account of the misses, and therefore considerable torsion (which may result in breakage) is produced in the crankshaft.

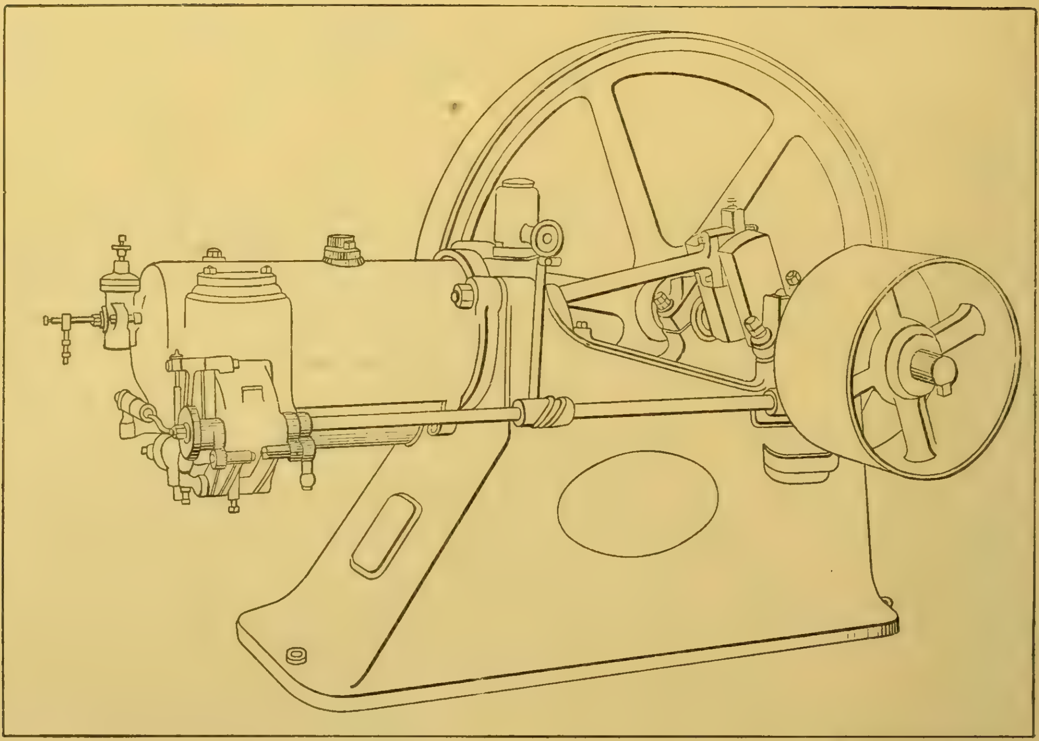

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FIG. 3. ENGINE WITH ORDINARY FLY-WHEEL.

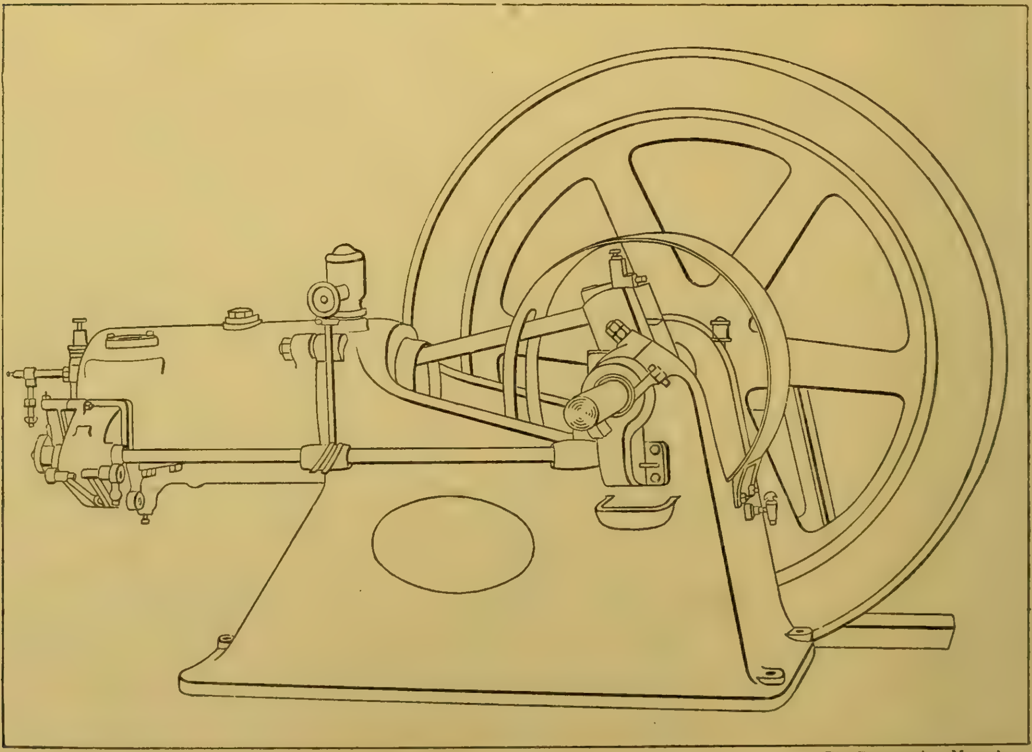

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FIG. 4. HIT-OR-MISS GOVERNED ENGINE WITH HEAVY FLY-WHEEL.

Nevertheless, the system of governing by hit-and-miss is still applied by most English designers, while all German designers have sought the solution of the problem in a different direction.

They made the governor act on the gas mixture in such a way that, according to the power which the engine was called upon to develop, there was produced:—

(I) A mixture of variable quality and constant quantity.

(II) A mixture of constant quality and variable quantity.

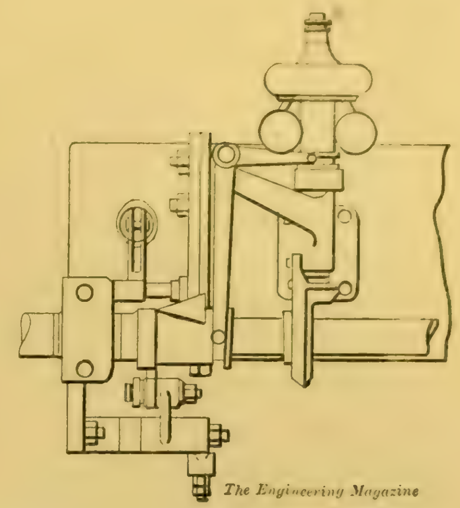

FIG. 5. REGULATOR FOR VARIABLE ADMISSION OF GAS.

Mixture of Variable Quality and Constant Quantity.—The governing device most generally used to obtain this mixture controls the gas-admission valve, through the interposition of a cam having a longitudinal conical section. This cam (called "conical cam") is connected to a lever depending from the governor, which according to its oscillations displaces the cam longitudinally on the cam shaft of the engine.

The result is variation in the duration and amplitude of the opening of the gas-inlet valve.

Another system consists of inserting, between the mixing chamber and the gas inlet, a circular slide having the same axis as the gas-mixing valve proper. The motion of this valve is controlled by the governor, so that the lat-

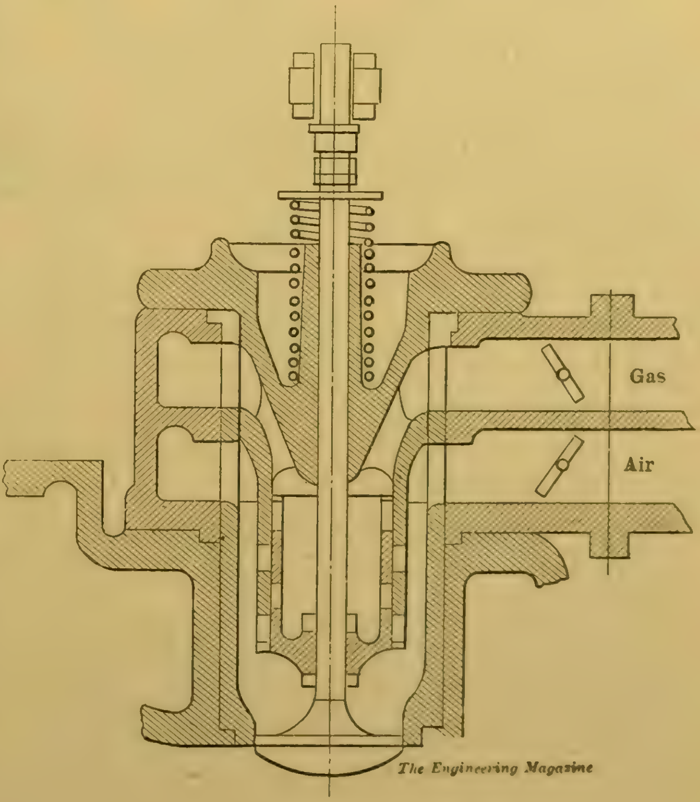

FIG. 6. MIXTURE REGULATING VALVE.

ter varies the quantity of gas in connection with the amount of air. It is worth mentioning that for engines working with poor gas it is frequently necessary to inspect and clean the parts of the two mechanisms just referred to, as they will get greasy very rapidly.

These mechanisms present certain difficulties:—

When the engine works under a light load, the gas valve opens so little that the actual quantity of gas admitted becomes so small in proportion to the air contained in the mixture that it will be very difficult to make the mixture explode. In order to obviate this defect, compression has been increased to 14-15 kilogrammes per square centimetre (200-213 pounds per square inch). With such high compression, very poor mixtures can be ignited; but when, on account of an increased load upon the engine, the mixture becomes richer, the ignition tends to occur very early, and may even happen before the crank has arrived at the inner dead center. This is what is called a premature explosion, and may cause a decrease in the speed of the engine and even stop it. What is more serious, however, is that it may cause the breakage of the crank shaft if the engine is of a powerful type.

Several designers, who have pushed the compression to about 15 kilogrammes per square centimetre (213 pounds per square inch) had to cool the cylinder and its valve or head end very energetically by means of an abundant water circulation in order to avoid these premature explosions. I have seen engines so governed in operation and the temperature of the cooling water when leaving the water jacket did not exceed 30-35° C (87-95° F); with engines having a lower compression, it can be made to leave at 50°-60° C (120°-140° F) without difficulty.

The "conical-cam" system requires further the use of a very heavy governor, sufficient to overcome the resistance opposing the motion of the cam, and due to the inertia of the pieces.

It must be considered that in practice, with engines using a mixture of variable quality, the machinist must manipulate the regulating butterfly valve of the air conduit when the load varies, so that a mixture which will explode readily in the cylinder is obtained.

Mixture of Constant Quality and Variable Quantity.—In this hypothesis the compression does not remain constant.

The quantity of the mixture drawn into the cylinder may be so much reduced that the compression will fall below the limit where ignition will take place. It is therefore necessary that engines should also work at high compression when supplied with this kind of regulation. The regulation of the quantity of explosive mixture is secured in different ways. The most simple method is to place in the mixing pipe a butterfly regulating valve, which, operated by the governor, will throttle down more or less the passage of the mixture.

An excellent practical solution of the problem is to vary the opening of the mixing valve itself. In order to do this the valve is moved by a system of levers. The point of application of one of these levers may be changed through the action of the governor, so that the stroke of the valve can be made to vary between determined limits. Under these conditions, a mixture which will always be homogeneous, and of such proportions that ignition will occur even at low pressures, can be introduced into the cylinders.

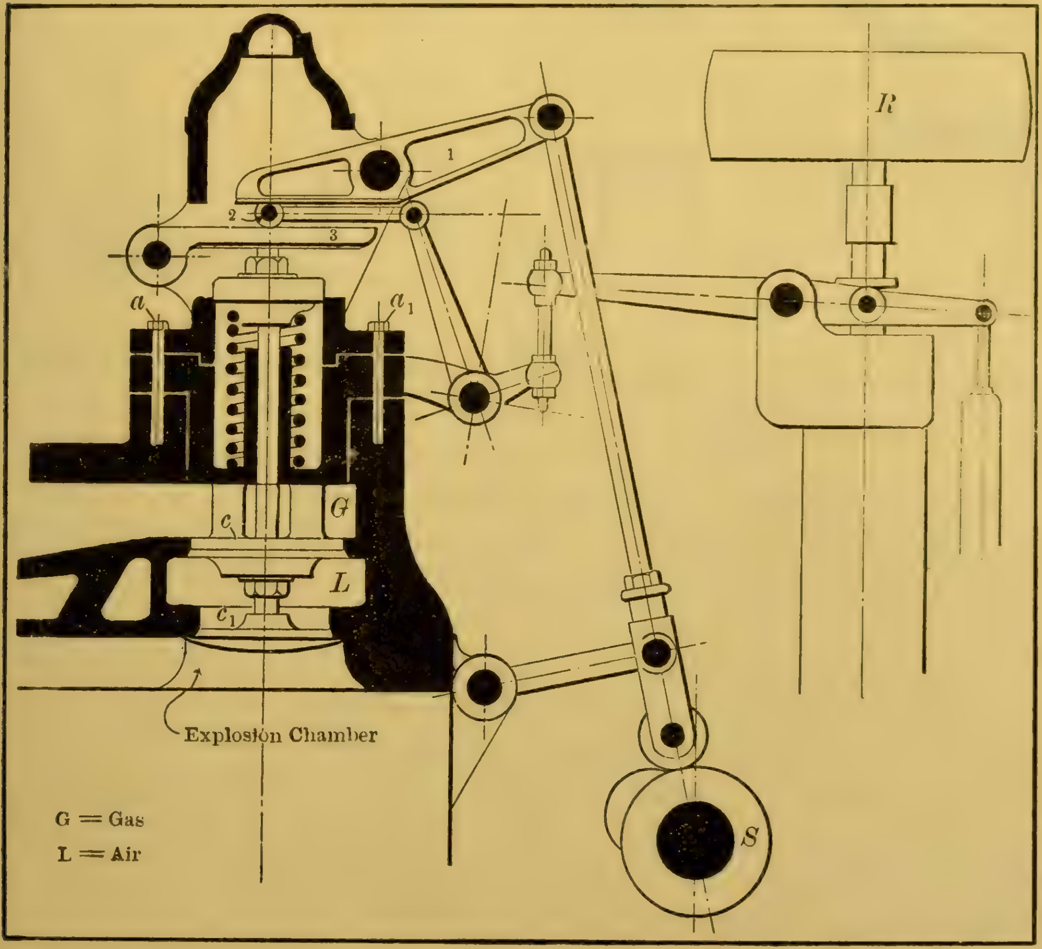

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FIG. 7. SYSTEM FOR VARIABLE OPENING OF THE MIXING VALVE.

I have ascertained, during recent tests of an engine supplied with these governing devices, that ignition was still obtained when compression went down to 3 kilogrammes per square centimetre (42.7 pounds per square inch). Besides this, a very economical consumption at half load as well as at full load has been demonstrated.

This system also has the advantage that ordinary governors which are not excessively heavy can be used, since the work to be done by these governors in order to change the point of application of the lever is relatively small.

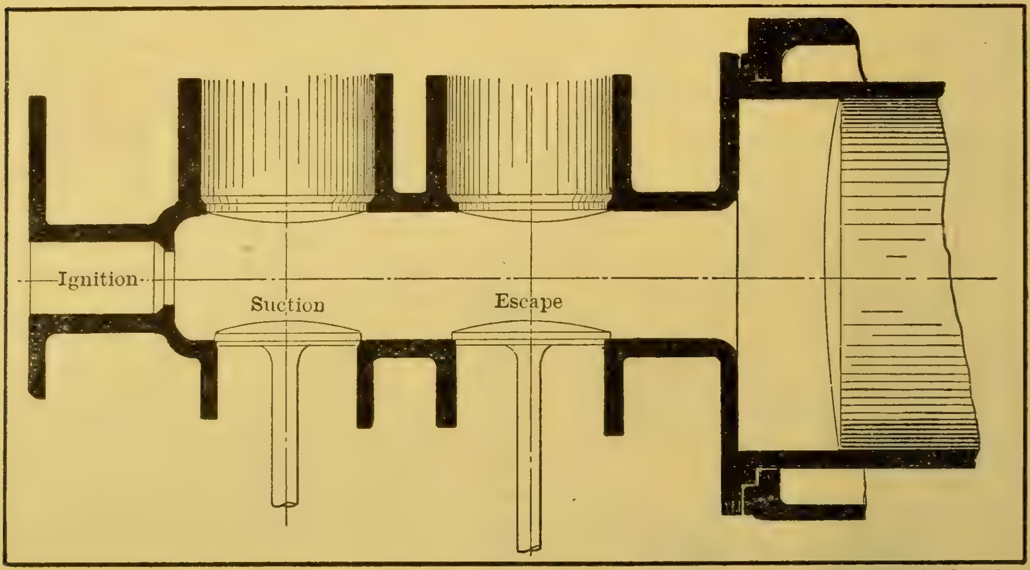

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FIG. 8. FORM OF HEAD END IN WHICH THE INLET AND OUTLET VALVES ARE IN JUXTAPOSITION IN THE AXIS OF THE ENGINE.

If the employment of a certain method of governing has a direct and important influence on the consumption of the engine, the form adopted for the construction of the head or valve end plays an equally important part.

English designers have tried to approach a spherical form as much as possible. With this form of head end a compression of 6 to 8 kilogrammes per square centimetre (90-110 pounds per square inch) can not be exceeded. Nevertheless, the gas-consumption of engines (that is, those of good construction) when running under full load is generally economical enough. It varies between 425 and 480 litres (15-17 cubic feet) per horse-power hour, for engines of 20-25 horse power, using a gas having a calorific power of 5,300 calories (600 British thermal units per cubic foot).

All German and Swiss designers, on the contrary, have adopted in the design and construction of the head end a form in which the mixture and outlet valves are placed in a pipe forming a kind of antechamber which is completely water-jacketed, and therefore assures a good and regular cooling of the valve seats.

With this arrangement, while the explosion chamber can quite well be reduced to a minimum, the great advantage from the point of

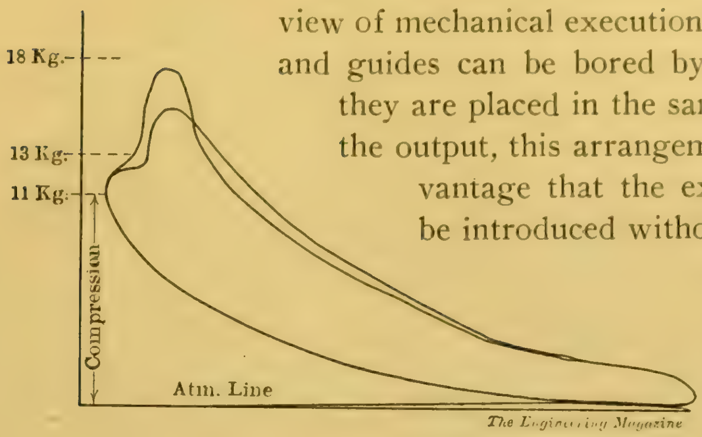

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FIG. 9. DIAGRAM OF GAS ENGINE ON THE SYSTEM SHOWN ON PAGE 362.

view of mechanical execution is that the valve seats and guides can be bored by the same tool, since they are placed in the same axis. Considering the output, this arrangement again has the advantage that the exploding mixture can be introduced without being heated when passing through the admission valve, since the latter is benefited by the cooling of the head end which is completely water-jacketed. Before arriving at this form of head end, other kinds had been used in which the inlet and outlet valves were placed next to each other in the axis of the engine itself. This arrangement gave great length to the head end and some sort of ignition was produced every two cycles, as the accompanying diagram shows. This model seems to have been entirely abandoned.

In double-acting engines the valve chamber is replaced by a cylinder head analogous to that of the steam engine. The exit valve is underneath the cylinder and the inlet valve above it and the piston travels over their openings during its stroke.

The diagrams obtained by me from double-acting engines show that the mean pressure obtained with this arrangement is much higher than that obtained with the cylinder head previously described. The arrangement adopted for double action would then seem to be advantageous. This consideration appears to have lead a Belgian designer to construct the cylinder heads of single-acting engines identically as it is done for double-acting engines. Experience will show whether it is advantageous to enter definitely upon this path.

TABULATING-MACHINE COST-ACCOUNTING FOR FACTORIES OF DIVERSIFIED PRODUCT.

By Morrell W. Gaines.

A GREAT deal has been written about cost-accounting method. Of able and illuminating expositions of the subject the articles that have appeared in The Engineering Magazine are among the best and the most complete. Cost-accounting analysis, on the other hand, has, in proportion to its importance, been as yet touched upon but lightly. Description of forms is, it is true, not altogether unaccompanied by elucidation of principles. But on the whole the science has been slighted in favor of the art. The objective of this short, general paper is, accordingly, the logic of costs from the view-point of the cost-analyst. Concrete illustrations, pertaining to the province of the cost-executive, will be introduced as auxiliary to the main theme, and only so far as necessary.

In theory all cost-accounting method is based upon, and derives its validity from, cost-analysis. The one is the plan of which the other is the execution. A cost-system thus constructed aims at two results. The first is negative—the curtailment of waste and expense. The second is positive—the making of increased profits through knowledge of profit-bringing qualities and conditions. Of the two the latter is vital, and the former merely incidental, though often the more emphasized. Factories are run to make money and not to practise economies.

In practise, cost-accounting method does not generally conform to correct principles of cost-analysis as closely or as completely as it should. This is in part due to lack of insight in the design, in part to lack of flexibility in the accepted medium of expression.

Cost-keeping by hand, with its hard-and-fast entries in ink, is at best but stiffly adaptable to the many-sided interrogations whose answer it is its function to provide. Limitation by rigidity of form, which makes it represent as absolute conclusions that are only conditional, is its great defect.

Cost-accounting by tabulating machine, (touched upon as to method by Mr. A. W. Buel, in the August number of The Engineer-

ING MAGAZINE), offers, on the other hand, the utmost flexibility, or, rather, fluidity, in mode of expression. Without the necessity of transcribing, its records permit the application of re-classification after re-classification to the same set of facts. They are, accordingly, for all analytical purposes infinitely to be preferred to the fixed-form, ink-entry records. The stride in advance is indicated, but not measured, by the analytical advantage of modern bookkeeping over the old single-entry process. New methods there have achieved one, or, at most, two, added classifications. Here at one step a facile multiple (not merely double or treble) classification is substituted for what was previously as a rule a single classification. The revolution in method admits now for the first time absolutely free and close application of searching analysis to cost-accounting.

The fundamental principles to be applied are few and simple. For the first function of cost-accounting—the curtailment of waste and expense—the old rule of classification according to units of product, in connection with scrutiny of expense totals, quite covers the ground. What is needed is simply the measurement and weighing of the physical results of expenditure.

For the second, and more vital, function of cost-accounting—the providing of a profit-criterion—measurement must be applied to receipts as well as to expenses, and that in more than one direction. Multiple classification, with several basic units, must be employed.

All knowledge of potential profits that experience may teach or reason create is, reduced to its lowest terms, no more than knowledge of the net difference in profit or loss which may be expected to follow choice between given lines of action. To determine this net difference with the greatest practicable accuracy is the main object of a cost system. For the profit-criterion, the fundamental principle is accordingly that of measuring differentials. This is a very different matter from the measurement of absolute quantities, to which cost systems too much confine themselves.

To cover the field of possible choice of action completely, producing units must be added to production units. There must be taken individual and group units of either class. The workman, the machine, the article, the salesman and the customer may be cited as examples of individual units; the department, the State or other division of locality, the combination of related articles into groups, are instances of group units. All manner of units are useful in their place, but since problems requiring decision tend to narrow themselves within definite, circumscribed portions of an active business, comparatively few of them will be required currently in the cost system. Further, since it is obvious that only that part of the receipts or expenses which is influenced by a given choice of action needs to be subjected to measurement in order to determine the resultant net profit or loss, a sharp, and most important, distinction is to be drawn between those receipts and expenses that are "direct" with respect to the course of action in question and those that are "indirect." All that will not vary with the choice of action are to be altogether discarded from consideration. This is not so much from motives of clearness and efficiency as of exactitude. The question of quantity of product is, in one shape or another, at the bottom of all questions of choice of action. If factors are included which do not vary with quantity the calculation becomes fallacious with respect to that very change of quantity upon which the whole profit-problem rests.

Direct and indirect charges are separated once for all in the ordinary type of cost system, regardless of the fact that charges which are direct, or within the sphere of influence, for one line of action may be indirect for another, and *vice versa.* Action involving increase of output beyond a certain point brings in at once new "indirect" charges. Action involving increase of output up to that point does not. Action affecting salesmen or foremen must rest entirely and directly upon "indirect" considerations. Change of material, of mechanical process, or even in the general complexion of the factory's output, may not only alter the direct labor expended on a given article but also may affect a whole series of expenses classed as "indirect." In any such case the "cost" of the individual article will not show rationally what has happened. Its coat of "direct" and "indirect," of unvarying pattern and size, can not be cut to fit the cloth of circumstance. An even greater source of confusion lies in the fact that the figures for total cost contain in indiscriminate burial factors that vary with change of quantity and factors that do not. The usual total-cost figures are accordingly not adapted for measuring profit differentials. When used as a basis for judgment, as they often are in the absence of anything better, conclusions are always somewhat wrong, and, sometimes, totally misleading.

Vexed waters lie deep over the question of proper apportionment of indirect charges. The differential plan circumnavigates the whole trouble by ignoring indirect charges altogether. On its schedules all items are direct although no charges are omitted. As is often the case, a little more complexity in the analysis produces a great deal more simplicity in the practice. For purposes of price-making, to be sure, some will undoubtedly prefer to cling, at least in part, to the established customs of reckoning. In that case the arbitrary increments can be used as before, without hindrance. But, as will be shown later, this is not only a waste of time; it is also by no means the better method. The tabulating machine provides more accurate, as well as simpler, means of approaching its goal than ink-entry cost-accounting is capable of.

In estimating the net profit or loss to be expected from choice of action, the first step is to pick out the units of expense (and receipts) suitable for measuring the effects of the particular class of action. Direct expense per unit subtracted from direct receipts per unit gives then direct net revenue per unit, or net contribution per unit toward all those expenses which are outside of the sphere of influence of the action, and which are with respect to it just as much "fixed charges" as are those especial charges which are "fixed," or invariable, with respect to all choices of action alike. This net revenue per unit being multiplied by quantity gives in comparative form the total difference in net profit or loss capable of being caused by choice. Subject to the necessary allowance in all cost calculations for margin of error, the process evidently affords the best possible rational basis for arriving at conditions of maximum profit.

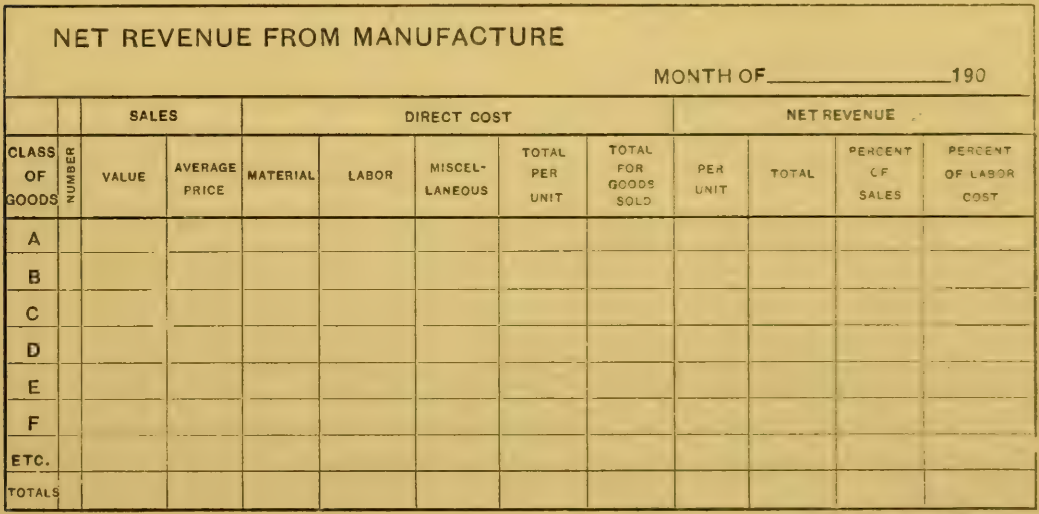
Before proceeding to the application of these abstract general principles it will be necessary to give some description of the tabulating machine and its *modus operandi*. Data are recorded by means of perforated cards whose arrangement may be so contrived as to fit any required schedule of units. Much care should be exercised in drawing up the details of the cards. As a rule, one schedule for expense and another for receipts may be made to include all necessary categories. There should be no hesitation, however, about using an additional form for any part of the records not easily assimilable to the rest. The main point, in fact the only essential, is to cause to be recorded by the machine *all* the direct expenditures and receipts originating under each of the chosen categories. Totals of outgo and income divided by totals of quantity give then cost and price figures about which there is no estimate, no omission, and no mistake. As regards accuracy, and immediate availability, of results—particularly where manufacturing processes are complex or output diversified—there is a decided advantage over the superseded method of building up costs out of approximated details. Shifting conditions can be followed. The actual costs of the moment can be worked out at short notice for any article desired. Facility replaces labor.

For the manufacturing side of the business, the cards should record date, list or catalogue number, order number, description of work done, hours worked, expense incurred, department, man and machine working, account to be charged, quantity made, and total expense. For the selling side, there should be recorded date, order number, customer, locality, salesman, freight and other especial expenses of sale, kind of article, quantity, and money value. These details should be gathered directly from the orders and other regular documents without intermediate rewriting. By means of a numerical code (which the operator memorizes) explanatory, or preparatory, dressing up of the figures is reduced to a comparatively negligible minimum. Ruled forms on the back of factory orders, or accompanying tickets, can be used to good effect both in lightening clerical work in the shop and in making an easy presentation of the facts to the machine. The fact that the information about an order may come to hand piece-meal, from many sources and at different times, does not in the least affect the ease of recording.

For the exclusion of uncompleted work from the final cost computations serial order-numbers should be employed in the works. Where partly finished material is used for more than one kind of finished article there must be a separate order number up to the point of diversion; the cost up to that point, having been arrived at, can be carried into the cost of the finished articles through the channels provided for "material used." Where the time of a man, or of a machine, belongs to two or more orders simultaneously, or is otherwise difficult of apportionment, there must, of course, still be partial reliance upon estimate, or upon experience.

Some lines of action are so seldom involved, and so readily approached through the medium of blanket totals, that their figures and their peculiar categories do not need to be entered upon the cards. Such are, generally speaking, those relating to expenses of investment, as for example outlay for plant, patterns and machines, expenses of corporate existence, as those for taxes, time depreciation and fixed interest, and expenses of organic maintenance, such as shop "overhead" charges, much of the "general" expense, and, largely, cost of power. All these can be better taken into consideration in bulk than in detailed apportionment in those infrequent, but not unimportant, relations where they are appropriate. Outbound freight can not usually be further subdivided than by locality and customer. Sales expenses, "indirect" from the standpoint of manufacturing problems but best considered "direct" from the selling point of view (because in a rightly managed business they ought to vary with quantity of sales) resist dissection to a still further degree.

Although the information recorded is much more extensive than under the older cost systems, the operation of the machine is both rapid and cheap. Three thousand to four thousand cards punched per day per operator is a fair average. The principle is, as nearly as may be, one punch to a fact. Preparation of data before punching is quick work. Sorting of the cards, running them through the machine, and taking off results, is automatic. As incidental to the general process, records of daily sales, pay-roll and time figures, along with much, or all, of the intricate classification work previously carried on the books, may be developed, or checked, without additional labor and with a great saving of accounting department time. It takes two or three months only to train an apt green operator sufficiently well to ensure accuracy. The net cost is not at all heavy.



NET REVENUE FROM MANUFACTURE

MONTH OF______________190

		SALES		DIRECT COST					NET REVENUE			
CLASS OF GOODS	NUMBER	VALUE	AVERAGE PRICE	MATERIAL	LABOR	MISCELLANEOUS	TOTAL PER UNIT	TOTAL FOR GOODS SOLD	PER UNIT	TOTAL	PERCENT OF SALES	PERCENT OF LABOR COST
A												
B												
C												
D												
E												
F												
ETC.												
TOTALS												

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FORM FOR ANALYSIS OF REVENUE DERIVED FROM SALES OF VARIOUS CLASSES OF PRODUCT.

As to the extent to which the records shall be used, and indeed as to their completeness and form, wide latitude is allowed the individual management. Just as the preceding paragraphs on principle and means have conveyed the barest outline, so those that follow on practical application are a shadowy and incomplete sketch.

On the manufacturing side of the business one of the most common forms of choice of action is that which arises when the relative profitability of different lines of goods is under consideration. The problem may be reduced to its working elements by the use of a form like the one above, filled in periodically for all classes of product, and occasionally for one or more about which there is immediate question.

Net Revenue is the difference between actual Price realized and Direct Cost.

In a majority of instances the manufacturer will wish to consider the relative profitability of the different lines and classes of goods with reference to choice of action that will not involve changes in factory organization or in fixed investment. For all these cases the Net Revenue figures as arrived at on the above form will give him the profit criterion he seeks. Where choice of action reaches further, and disturbs the existing amount of overhead charges, or of other expenses herein discarded as being fixed with reference to the possible actions involved, the changes so induced in other classes of expense must be entered as "direct" under the necessary additional columns. The general plan is the same. All expenses not subject to alteration within the limits set by the inquiry desired to be made, are, as shown in the form, simply omitted.

As to the cost-analysis, or, better, profit-analysis, to which this statement conforms, it will be noticed that the plus and minus differences between successive net-revenue figures are almost, or quite, the same as the differences between the two corresponding net-profit figures would be if the usual total costs had been used, but that the relative proportions are altogether different. Some lines of goods too, that would show a negative net profit, keep, nevertheless, a substantial positive net revenue. The net-revenue figures show corrctly, and in their true mutual relations, the contributions brought in by sales of the individual articles towards the general up-keep of the establishment. Therein lies their strength. The weakness of the net-profit figures lies in the fact that the tax for that general up-keep is subtracted from the contribution before comparison is made, so that what is finally compared is the resultant of two factors that obey separate laws of variation. Such a resultant is naturally not conformable to logical, law-following analysis, while either of the factors taken alone, and especially the more variable net-revenue factor, is conformable.

Net revenue per unit shows the additional income to be expected from an additional sale. It expresses the differential of gain or loss for the choice of action with respect to which the selected unit is the measure of force. The amount to be made or lost by increasing, or cutting off, sales of any class is apparent on the very face of the sheet. The net results to be anticipated from "pushing" one line of goods at the expense of another, of substituting one line for another, of raising or lowering prices (where probable effect on quantity of sales is known) can be readily computed. Diagrams for graphic analysis will be simple straight-line figures, and they may be used to great advantage.

As to practical results, the manufacturer who is not getting the income that he ought out of his business can see, spread out in detail, where and why the deficiency arises. Sometimes loss of earnings comes from laying too much emphasis upon specialties, or small lines of high-profit goods, to the neglect of the tonnage-making low-grade articles. The fallacious relations presented by net-profit figures have a strong tendency to bring about this condition. Sometimes, on the other hand, the wider market for low-margin articles tempts manufacturers too far away from vigorous pursuit of profits that would come from a greater individuality of product and more energy in placing it. All such distortions of judgment, or lapses in economic efficiency, can be corrected in the light of the true proportions of the net-revenue figures. They give for each line of goods the full story of the relation of volume of business to final income.

Conformity to the relation between volume and profits is the essence of profit-efficiency in manufacture. Yet as a practical matter the considerations that may be deduced from a similar analysis of the selling side of the business are still more important. That side is where the money comes from.

For the salesmen, and other selling agencies, a form like the following should be filled in at least once a year.

COMPARATIVE NET REVENUE OF SALESMEN

YEAR 190___ SALESMAN ______________

		SALES		DIRECT COST		NET REVENUE	EXPENSES OF SELLING				NET REVENUE FROM SALES		
CLASS OF GOODS	NUMBER	VALUE	PRICE	PER UNIT	TOTAL	TOTAL	FREIGHT	SALARY ECT.	TRAVEL	MISCELLANEOUS	TOTAL	PERCENT OF SALES	PERCENT OF DIRECT COST
A													
B													
C													
D													
E													
ETC.													
TOTALS													

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FORM FOR ANALYSIS OF SALESMEN'S RETURNS.

This form is arranged with reference to the salesman as the unit. Units of production are used as far as the first Net Revenue (from manufacture) Total, simply for the purpose of obtaining that total. The ensuing figures are not divided by classes of goods. The sheet measures the results of the salesman's work. It has two immediate effects. One is that, like Taylor's unit-time measurements for the laborer, it puts men on their mettle. The other is that it enables proper choice to be made of the class of salesman, and of the individual in the class, best adapted to bring in profits. Manufacturers have more at stake in the quality of their salesmen than jobbers—in proportion, that is, to the amount of business done. That is because the net revenue of the latter is so much smaller, 'direct cost' for the jobber being the price the manufacturer gets from him. Slack, desultory selling mechanism on the part of manufacturers would be remedied if the real import of the salesman's doings were measured through net-revenue figures. Cheap men can not be expected to be efficient. The pay should be proportioned to the importance of the job, and to the effectiveness of the incumbent.

Localities where selling expenses are not earned can be sorted from those where they are by means of a locality statement, drawn up substantially in the same manner as the salesman's statement. Deadwood can then be cut out. By taking states, or districts, as the unit in this locality statement, an interesting and valuable analysis of the sales territory can be made.

To return to the salesman proper; comparison of the prices he gets with those realized by other salesmen, and examination of the proportions in which he sells the different lines, will do much to show what his weaknesses and failings are. Gumption from headquarters can be infused at the right spot.

The salesman's sheet, in connection with the locality sheet, is of further interest as affording a basis upon which to decide whether to enter new fields of sale. The advantage to be gained by widening the market is not by any means indicated by the net profits on the new amount of sales. This is especially so because just at the moment when general consumption slackens fixed charges per unit rise and net profit decreases or vanishes. It is, however, precisely then if ever that an enlarged market is needed.

Price-fixing is ordinarily determined more by the market than by what the manufacturer *wants* to get. Where there is an option, price should be set to bring in the maximum total of net revenue, always, however, with an eye to the probable competition. Absolutely the only use of the complicated addition of arbitrary percentage loading to cover indirect charges is that the process, being similar to that of competitors, gives an approximate idea of the prices they will make in competition. As the arbitraries are unlike in different factories, this psychological advantage does not invariably hold water. To cite a case that has recently appeared in print, Mr. James Newton Gunn's experience with machine shops has been that it is necessary to take small jobs to small shops because the shops with big equipment throw their big fixed charges into their estimates. Direct expenses being equal, there would, of course, be just as much money in a given price for a large shop as for the small one. The theory of arbitrary loading has simply gone astray. This is by no means an isolated case. The number is legion of businesses that have decayed because the proprietors persisted in using arbitrary loadings suitable to internal conditions of the factory rather than to external conditions of the market. Still it is perfectly feasible for the manufacturer, using the new system, to set his prices by any means that suits him. All that is essential is that he should check his price, when set, by making up the net revenue figures to see what his returns really are.

Forms, similar in plan to the above, can be drawn up to fit other needs. Records of men, of machines, of departments, of product groups, and of producing groups can be kept. These may be arranged for comparison with own past performances or with the performances of other homogeneous units. Every problem of choice of action, from those involving new investment to those concerned with concentration of production among existing factories, can be best and most clearly viewed when thus resolved into its direct elements.

In every walk of life there is a sufficiency of those who object to going without crutches. Bookkeeperish minds are particularly prone to the failing. The freedom of this type of analysis is not likely to be relished by the "finished-and-finite-clod, untroubled-by-a-spark" sort, especially since there have been most satisfying, exact and methodical, forms to lean on. Cost-accounting truly belongs, however, to the trained mind of larger grasp and firmer footing. It should be one of the paths by which the engineer pre-eminently, from the very nature of his training, aims to pass upward to a sphere of wider and more intimate contact with the external problems of the business. That way lies increase of influence, as well as increased usefulness.

The new system means facts for the "practical" man, insight for the analytical. For the trained engineer, as for the broad-minded executive, it offers knowledge that is power.

PROBLEMS OF THE EXPANSION OF THE AMERICAN COAL TRADE.

By Frederic Edward Saward.

In a preceding article, Mr. E. C. Eckel, of the United States Geological Survey, pointed out the enormous proportionate part played by the coal and iron industries in the total mineral production of the United States. The accompanying paper by Mr. Saward, editor of the *Coal Trade Journal,* deals in more detail with the factors affecting the present and future of American coal mining and export. It will be followed shortly by another contribution from Mr. Eckel, pointing out most instructively the important significance of recent progress and immediate prospects in the American iron and steel trade.—THE EDITORS.

THE whole history of coal is a wonder story. It is wonderful in many ways—from its use as a source of motive power, from its value as an earner of income to the owners, and as freight to the carriers. Coal gave Great Britain the mastery of the world's markets and its carrying trade, until Germany and the United States entered the field effectively in the last quarter of the past century, when the development of German and American coals warmed these two countries into a neck-to-neck race for commercial supremacy. Starting in 1875, the race of the great leaders in coal production stood as follows:—

	Million tons (of 2,000 pounds each) Mined.				
Countries.	1875.	1885.	1895.	1900.	1904.
Great Britain	150	178	212	252	260
United States	52	111	193	269	352
Germany	53	81	114	164	186

If the rate of increase which has characterized the industry in the United States for the last ten years, or the average rate of increase for the last fifty years, should be continued, what an enormous output the next ten years will show! It will be, ten years hence, a tonnage in excess of 700,000,000 per annum. This amount is so great that one may well question if the railroad facilities of the United States will permit of such a growth. The whole freight traffic of the country today is one billion four hundred million tons. This includes duplication of tonnage to the extent of hundreds of millions, through cars of freight passing over two or more roads. It may be questioned if the actual tonnnage of commodities handled by the railroads exceed in weight 700,000,000 tons, as so many shipments are counted in the freight traffic of from four to six railroads. There are some arithmetical progressions which soon reach the bounds of absurdity. Possibly the percentage increase in coal output, which the records of the past indicate, is one of these. At any rate, the figures are phenomenal, indicating, by the year 1909, an annual tonnage of 501,000,000 tons. Who can deny the potentialities of the coal trade? Is it not a fact that the extent and importance of this business is altogether unrealized by the general public? Do not the figures indicate a wonderful future for owners of coal land and for all who are interested in the business in a large, substantial way?

The following table shows the amount of the coal production of the United States in 1904:—

State.	Production.	State.	Production.
Alabama	11,163,194	Montana	1,359,409
Arkansas	2,009,451	Nevada	150
Cal. and Alaska	75,388	New Mexico	1,452,183
Colorado	6,594,295	North Dakota	269,297
Georgia and N. C.	400,191	Ohio	24,415,054
Idaho	3,330	Oregon	111,540
Illinois	35,990,796	Pennsylvania	97,916,733
Indiana	10,929,908	Tennessee	4,782,302
Ind. Territory	3,011,972	Texas	1,072,194
Iowa	6,542,005	Utah	1,491,607
Kansas	6,322,875	Virginia	3,576,092
Kentucky	7,559,940	Washington	3,135,757
Maryland	4,819,171	West Virginia	32,332,385
Michigan	1,338,447	Wyoming	5,177,381
Missouri	4,187,197		

Total Bituminous	278,040,244
Pennsylvania Anthracite	73,156,709
Grand Total (tons of 2,000 pounds)	351,196,953

The total for this year will be 5 per cent. more than that of 1904, as the trade demand has been excellent for the past four months; this means a daily output of over a million net tons of coal a day.

A large amount of the soft coal produced in the United States is mined by machinery. A record of the progress therein is shown in the following statement. It is noticeable that the great district of western Pennsylvania, Ohio, Indiana, and Illinois—the bituminous district wherein the United Mine Workers' organization is strongest—is the greatest user of mining machines.

Year.	Machines Used.	Tons Produced.
1901	4,341	57,843,335
1902	5,418	69,611,582
1903	6,658	77,974,894
1904	7,671	78,692,407

That the use of mechanical cutters is rapidly passing out of the experimental stage in Great Britain is evidenced by the following table showing the increase in the number of machines and the tonnage produced during the last three years:—

Year.	Machines Used.	Tons Produced.
1902...............	483	4,161,201
1903...............	643	5,245,578
1904...............	755	6,744,044

Thus there has been an increase of over 56 per cent. in the number of machines used, and an increase of over 60 per cent. in the product. The greater number of machines are used in the Yorkshire and Lancashire districts, and a great future is predicted for them in the Midlands. The South Wales district, noted for its "smokeless" coal, reports an output of 43,730,415 tons in 1904, but there are only nine machines in the Cardiff district, and their product amounted to only 40,986 tons.

There has been a vast quickening in the coal trade in the United States during the past few months, and it is claimed that it is due to short car supply. Whether there is really a scarcity of cars, or whether short transportation facilities are only apparent because of the great demand from all branches of the industrial world, the fact remains that coal producers are not able to secure as many cars as they need, and yet not damage the business so far as price is concerned. Every fall brings with it this condition, and perhaps always will, but it is worse now than ever before. There is no prospect that it will not be worse next fall than now. Railroad companies are purchasing an enormous amount of equipment, but it must be remembered that all lines of business are increasing in volume and that the railroads are covering more territory each year. Another thing, a large proportion of this equipment goes to takes the place of that which is worn out and goes to the scrap pile. Every firm or company that is producing coal must, therefore, understand that while there will be more business and a greater demand for fuel each year, transportation facilities in the fall will always be taxed—that is, when financial and industrial conditions are normal

As to labor matters and the possibilities: There is a joint agreement between the men and their employers in the bituminous districts of the United States, covering what is known as the Interstate, or competitive, territory, which comprises western Pennsylvania, Ohio, Indiana, and Illinois, and this agreement, which was made in April, 1904, expires by limitation April 1, 1906. An understanding by which the anthracite miners received a basic rate of wages was entered into in April, 1903, and that also expires at the same time, in April, 1906. So it will be seen that where the United Mine Workers are strong, the wage agreements of both anthracite and bituminous miners expire at the same time, and of course new arrangements, or agreements, must be entered into before that date. A convention of the anthracite miners is to be held December 14, of the current year, to formulate demands for another year or more, while the Interstate district miners will meet in January to formulate their demands to be submitted to a joint convention of operators and miners, in February. The union leaders claim a membership to their organization of about 300,000 out of a total of 550,000 employed in the United States, and while there are many foreigners, such as Poles and Hungarians, employed in and about the mines, as a rule they are all good unionists, and they do not work for a longer period per day than in other countries, for the eight-hour day prevails in many States. It is a fact that since the union has gained strength in the coal industry, wages have been increased very materially, and there have been claims and demands almost every year for higher wages and for fewer hours of work. In the anthracite region the miner does not work an average of five hours per day, but the outside laborer, and the man who follows the miner to load the coal which the latter has dug, formerly worked ten hours, but by the decision of the Anthracite Commission this was cut to nine hours. The effort is to be made for a universal eight-hour day, such as prevails in the bituminous districts where the union is powerful. This is one of the great features of the union demands—a universal eight-hour day.

In the anthracite regions there was a 10-per-cent. increase in wages five years ago; there was another increase of 10 per cent. in 1903, and Mr. Samuel Gompers, of the Federation of Labor, estimates that the extermination of "store orders" and the payment of wages in cash is equivalent to a 10-per-cent. increase in the purchasing power of the wages of the miners. Formerly everybody was paid in orders on supply stores managed and owned by the operators, where every miner had an account and bought what he wanted on credit. At the end of the month, or whenever pay day occurred, he presented his order and it was credited on the books against the purchases he or his family had made. This credit system was a great temptation to the miners and their households; they bought many things they did not need, and bought more than was necessary of what they did need.

because they did not realize how much they were spending. Now that they receive their wages in cash, they can trade wherever they can get the best bargains, and as a rule they are much more economical in the expenditure of their money. Mr. Gompers thinks that it is worth more than 10 per cent. for a miner to have the privilege of handling his own money and buying where he can use it to the best advantage. Then they get an advantage in the rise of coal prices, of 1 per cent. on each 5 cents per ton advance. The minimum price was fixed by the Anthracite Commission, and wages are based on that.

In the ownership of the anthracite coal territory there has been increasing concentration in the past few years; the high prices offered make it profitable to the old owners to dispose of their property to the large corporations. Since 1896 the anthracite production and transportation has been conducted harmoniously by the corporations which control the industry. For several years it has not been necessary to hold conferences as to trade affairs. Each company proceeds apparently on its own initiative, year in and year out, but for a long time each of the great companies has produced a certain proportion of coal to the total output, prices have been steadily maintained, and on occasions the companies have stood together, as during the strikes of 1900 and 1902, yet they have been separate and apart. There could be no greater harmony of action than there has been in the last three years, if there were to be another dissolution of the nine companies and the creation of one corporation in their stead. But this unwonted harmony during so long a period between competitive companies engaged in the struggle for business and traffic was due, in great measure, to the artificial arrangement put in operation by President Roosevelt's strike commission which has dominated the anthracite coal industry, bringing not only the competitive producing and transporting companies into harmony, but encouraging the lion of capital and lamb of labor to lie down together. It is recognized that when this compact ends next April the forces of capital and labor will at once be arrayed against each other, the demand for an eight-hour day and recognition of the Union being the vexed points at issue.

The progress of the shipment of anthracite in the past few years has been as follows:—

Year.	Tons.	Year.	Tons.
1902..........	31,200,890	1904..........	57,492,522
1903..........	59,362,830	1905..........	60,000,000

The year 1902 was that of the long strike, lasting the greater part of six months, from May to September. In ten months of 1905 the shipment was 50,593,504 gross tons, so that the estimate of 60,000,000 is none too large for the current year.

That there are years of prosperity ahead of the coal trade is unquestioned; the mere enlargement of the American railroad system will take care of 5 per cent. annual increase in the bituminous output. From all present indications the year 1906 will see extraordinary activity in railroad building in the western part of the United States and also in the Dominion of Canada. Almost all the prominent railroad systems in the western part of the country, including the important Canadian companies, are contemplating the building of additional lines, for the purpose either of opening up to settlement new agricultural lands to supply the *bona fide* demands of the increasing number of new settlers who are desirous of taking up homesteads, or of tapping new mineral sections. There is also in contemplation by the railroad managers the building of many miles of new lines to shorten present lines and to avoid the steeper grades, which will, when completed, be a great factor in the more economical management of the roads. With a view of more expeditiously handling the traffic on several of the roads, there will also be built several hundred miles of double tracking, which will undoubtedly be the source of much additional revenue and of important economies in transportation when completed.

One of the most important features in regard to the American coal trade is the fact that so much of the coal is used at home. Great Britain exports are reported at 48,250,000 gross tons, and in addition there is supplied a total of 17,000,000 gross tons more to steamships engaged in the foreign trade. Exports from the United States—mainly to Canada and Mexico—are reported as amounting to 8,500,000 gross tons in 1904, and bunker coal is perhaps a total of 10,000,000 gross tons, so that the relative position is this:—

	United States.	Great Britain.
Production of all kinds.......	352,000,000	260,000,000
Exports and bunker..........	20,720,000	73,080,000

(Reduced to tons of 2,000 pounds.)

There are many producers in the United States who are of the opinion that the country should do more in the way of an export trade—particularly is this the case with those soft-coal producing concerns in the Southern States, where development is on a rapid scale. The solution of the problem of securing an export market, needless to say, is indissolubly bound up with that of enlarging the American merchant marine.

A TUNNEL ON THE GRUYÈRES ELECTRIC RAILWAY.

THE ELECTRIC RAILWAY OF GRUYÈRES.

By Emile Guarini.

The accompanying short illustrated description is given as typical of much of the work now being done in the construction of electric railways in Switzerland. The abundant water powers of the country are especially favorable to the development of similar traction enterprises and allied undertakings.—THE EDITORS.

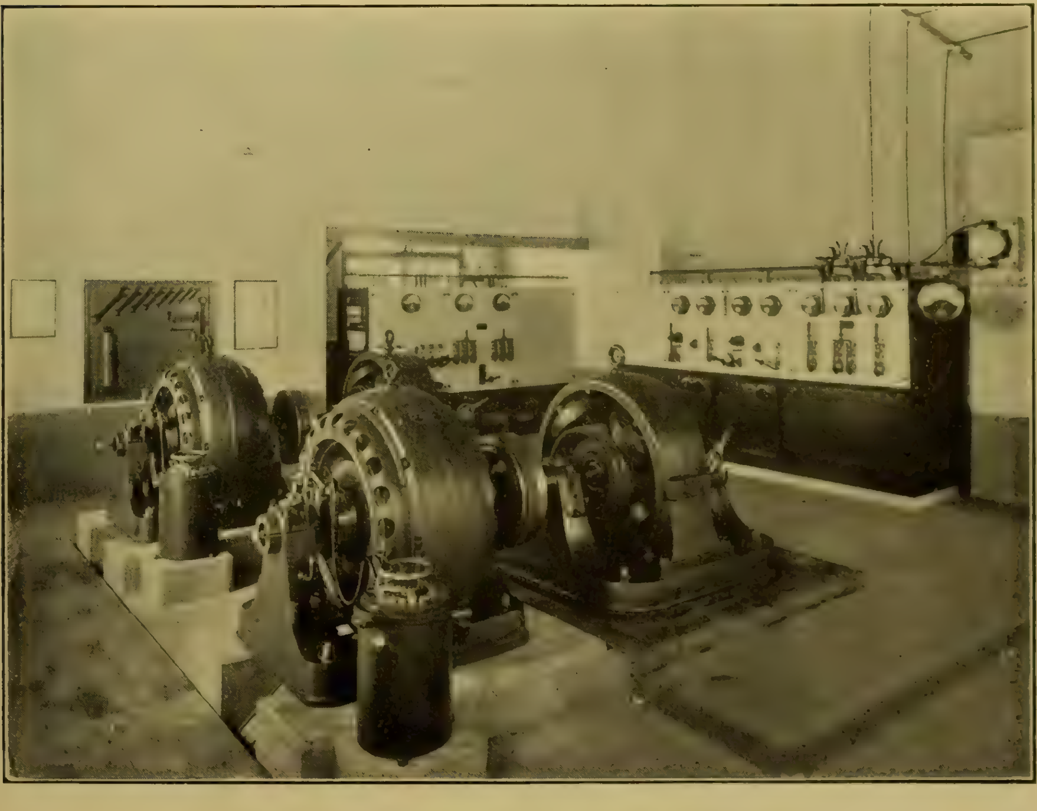
IT is only within recent years that a railroad has been in operation at Gruyères, Canton of Freiburg, Switzerland. This line, which is worked by electricity, connects Montbovon with Palézieux, passing through the towns of Albeuve, Bulle, Semsales and Châtel-St.-Denis. At these points transforming stations have been erected for the purpose of stepping down, to a tension suitable to the motors, the currents of high voltage which are supplied by the hydro-electric central station at Montbovon. This central station was erected through the efforts of the Alioth Company which has also equipped the system referred to.

The sub-station at Bulle is the most important; it is equipped with two sets of rotary transformers, each having an asynchronous motor of 250 horse power, direct-coupled to a dynamo. The asynchronous motors are fed directly at 8,000 volts by the three-phase currents from Montbovon. These currents are distributed among the sub-stations by means of sectional conduits so arranged that the total loss in the circuit does not exceed 12 per cent. under the most unfavorable circumstances.

The motors, of Alioth type (as are all the other apparatus used on the line) are each coupled flexibly to a generator furnishing continuous current at a tension of from 750 to 1,000 volts.

The load, owing to variations in the traffic, cannot be maintained at a uniform rate and is, therefore, regulated by means of booster batteries; that is, an accumulator battery of suitable capacity is employed in conjunction with the generator. This insures the apparatus working under conditions as near the full load as possible.

At Bulle the battery has a capacity of 370 ampere hours and is formed of 375 elements. This battery is charged during the slack hours of the traffic, that is to say when there is least traffic demand



INTERIOR OF TRANSFORMER STATION, ALBEUVE.

for current on the line. In proportion as the railway use of the current increases, the potential is lowered to the limits of the generator. A moment occurs when the battery no longer receives current, and, in fact, when, the load still increasing on the line, it restores to the latter the power which it had accumulated from the generator.

Similar conditions prevail at Albeuve, Châtel-St.-Denis, and Semsales; but there the apparatus is less powerful; each sub-station simply has two sets of 70 kilowatts, with a reserve set of the same power, which could be utilized in case of necessity. A similar reserve group, but of 170 kilowatts, is also provided at the sub-station at Bulle.

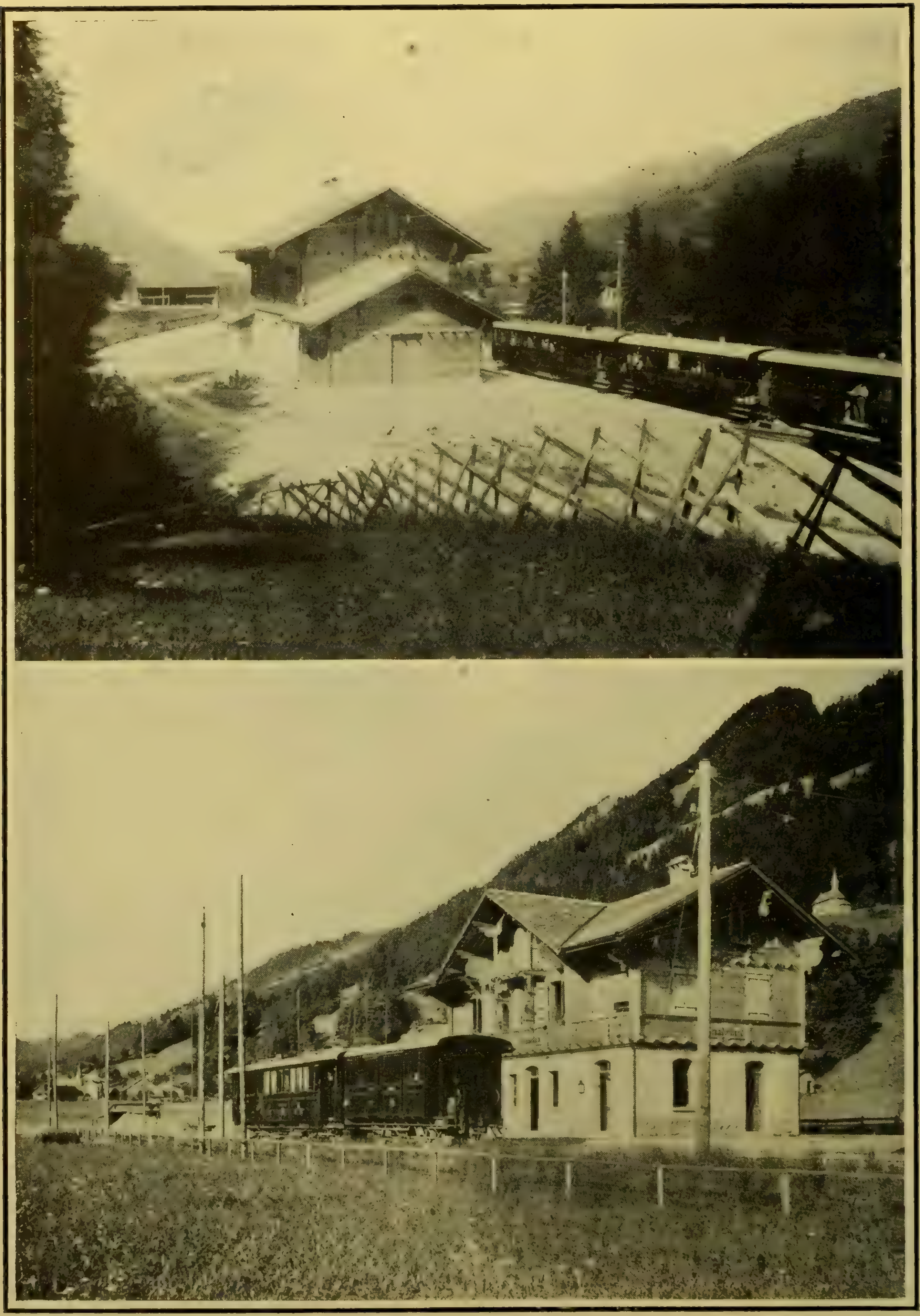
A MINOR ROAD CROSSING. SHOWING THE GENERAL CONSTRUCTION OF THE LINE.

The groups of transformers consist each of an asynchronous motor, coupled by a flexible sleeve to a continuous generator. These machines make 500 revolutions a minute, the frequency in the case of the motor being 50 periods per second. Here the machines do not receive current under 8,000 volts, a preliminary transformation taking place in the towers, on entrance into the sub-stations, by means of a static reducing transformer, which brings down the electric pressure to 500 volts, the tension at which the current is employed in the motors. Near these, in each of the sub-stations, are placed the starting apparatus.

RAILWAY AND ROADWAY BRIDGES.

The batteries in the last three transforming stations have a capacity less than that mentioned for the Bulle station. The capacity, which can be consumed in an hour, is only 115 ampere hours, the number of the elements being reduced to 170.

The switch-boards are formed of panels of white marble, set in wrought-iron frames, with partitions of perforated sheet iron. This



EXAMPLES OF BUILDING CONSTRUCTION AT MINOR STATIONS.

The upper picture shows the station at Lessoc; the lower, that at Grandvillard.

ensures proper ventilation and protects the apparatus from all danger of contact.

There are three tri-phase panels and four continuous-current panels, the two groups being separated but well within sight of the electrician. Each of the three-phase panels corresponds to one of the groups and carries the necessary measuring, controlling, and safety apparatus. One of the continuous panels is reserved for measuring the tension of the feeding and charging currents. The other three are used for the generators.

A PRINCIPAL STATION—CHÂTEL ST. DENIS.

The conductors are led into the building through specially constructed towers. The continuous current of 750 to 1,000 volts, produced by the generators (assisted, when necessary, by the batteries) is conveyed to the overhead conductor. This is formed of hard-drawn copper wire, of 9 millimetres diameter (or a section of 63.6 square millimetres) and supported, by means of insulators, on pine-wood posts treated with an injection of chloride of zinc; this increases the resistance to the earth acids and protects the posts from the weather. The suspension is generally effected by special brackets, but double masts with wire stretchers and guys are also used, this method being adopted on curves.

The height of the wire above the rails also varies according to local-

A MOTOR CAR ON THE GRUYÈRES RAILWAY.

ity; in all cases, however, the suspension is elastic, so as to avoid the necessity of reversing the collector used in taking up the current. This collector consists of a large metal ring kept in contact with the line by means of springs, the upper part, which consists of an aluminum band, rubbing against the electric conductor. The suspension points of the wire are so arranged as to distribute uniformly the wear on the bow trolley. It might also be added here that, in order to facilitate repairs and inspections in case of accidents, the line is divided into sections of 1,600 metres long; the posts are placed 40 or 20 metres apart, 20 metres being the distance at curves. Every fourth or fifth post is provided with a lightning arrester. The feeder cables and the telephone lines are suspended from the same supports which carry the overhead wire; the height of the posts is 8, 9 or 10 metres, and they are set 1.25 to 1.75 metres in the ground.

From the line, the current passes through the flexible bow trolley to the controller. The motors are of 35 or of 60 horse power. There are six motor cars regularly used and three held in reserve, each equipped with four motors of 35 horse power; and two motor cars, with a supplementary one in reserve, of higher power. The four small motors are always connected in two groups of two motors in series; the large motors, in two groups of two motors in parallel.

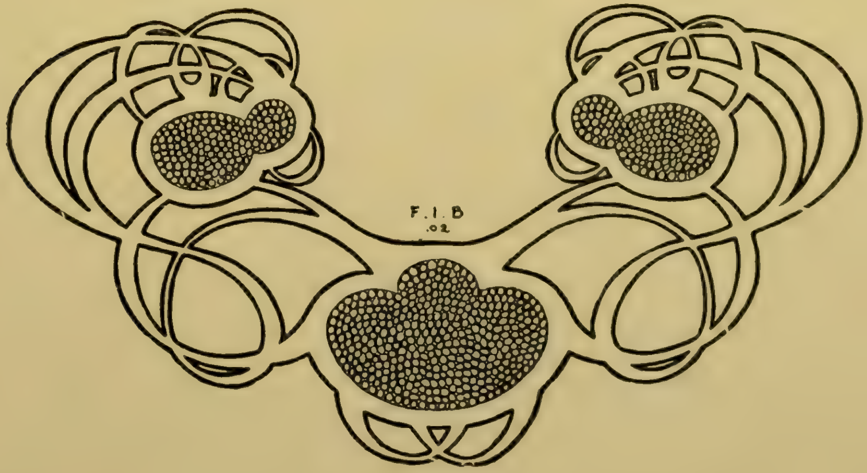
The groups are, in turn, placed in series or in parallel by the aid of the controller, as required.

The rotary speed of the motors is 550 revolutions a minute. This is reduced to the requisite wheel speed by gearing. On steep inclines the speed is maintained at about 20 kilometres an hour for ordinary passenger trains (47 tons) and 17 kilometres for goods trains (60 tons) and large passenger cars (130 tons, with four motors of 80 horse power).

The electric current is also employed for lighting purposes; five lamps of 150 volts are placed in series between the conductors (line and earth); it is used also for heating radiators, each having two windings in series permitting three grades of temperature being maintained; while a small motor works a pump which controls the pneumatic brake with which the cars are equipped.

The cars themselves are commodious and of elegant construction, being built of oak and pine, with fronts of sheet iron.

The roadway consists of two rails placed at a distance of 1 metre apart and resting upon a well ballasted surface, 2 metres wide and 35 centimetres deep. They are attached transversely every 200 metres by means of copper wire soldered at both ends. The rails are electrically bonded. To effect this bonding, the ends of the abutting rails are carefully scraped and cleaned in place, after which there is applied, with the interposition of a plastic amalgam, a copper plate measuring at least 100 square millimetres in section, which is firmly fastened in place by means of an angular fish-plate.



HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker.

IV. FUNDAMENTAL CONSIDERATIONS IN THE DESIGN OF TOOLS AND MACHINES.

Mr. Becker's articles, prepared in part in collaboration with Mr. Walter Brown, are based upon an exhaustive "try-out" of the new alloy steels in one of the largest American shops. The series began in our issue for September last, the first section being devoted to showing that the manager will generally find it to his advantage to replace carbon-steel by alloy-steel tools only gradually, under expert advice, and to adapt his existing equipment, so far as possible, to the new conditions and work it to the limit until it is worn out. The second part dealt with the internal adjustment of shop conditions—both as to men and jobs—to the use of the modern tools. The third (last month) took up in working detail the manufacture and treatment of alloy-steel tools and the apparatus needed for that purpose. The paper now presented deals with the operation of the tools and the machines carrying them.—The Editors.

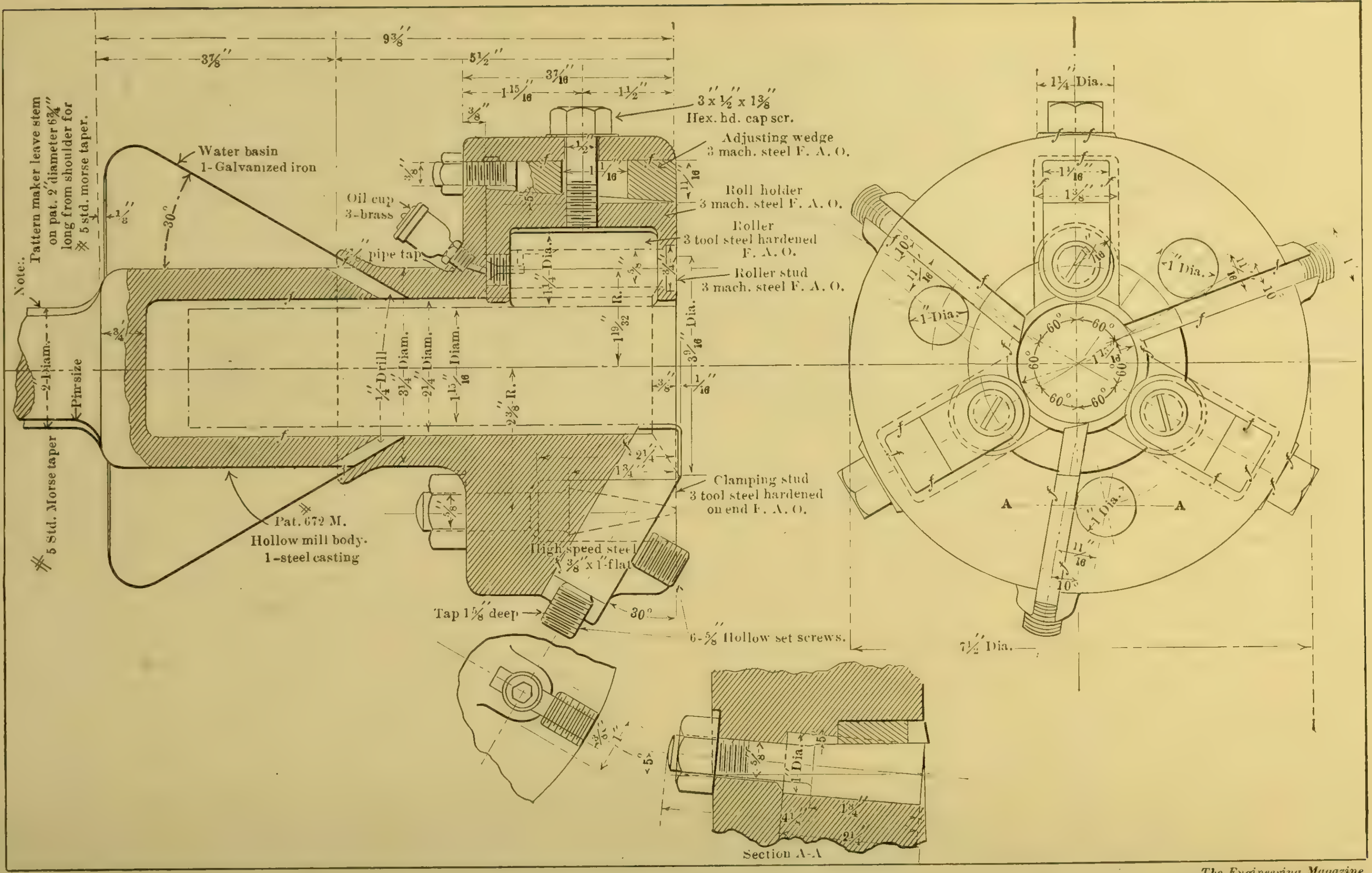
OBVIOUSLY, the prime motive in machine and tool design is efficiency. One productive apparatus is preferred to another because it turns out a greater quantity of the required product at the same or a less cost. Highest efficiency then involves the maximum production (satisfactory in quality) at minimum cost. Now the chief element in cost is usually that of labor—that is to say, time. Wherefore it is commonly assumed that a tool which works most rapidly is *ipso facto* most efficient. There are however other considerations not infrequently of equal importance with time. Certain of these, as the proper making of the tool, have been already discussed; and others, as the influence of the machine in which it is used, will be touched upon hereafter. It remains to consider here the influence of design on the efficiency of tools.

It has been already pointed out that the new conditions involved in the use of high-speed tools necessitate greater cross section in most of them than has heretofore been customary. The exception is found in such tools as large reamers and cylindrical cutters, which have generally been heavier and stronger than necessary because the expense of machining away the excess of metal brought no particular compensation. For lathe tools, and others of similar form and method of holding, a section from a fourth to a half greater than the minimum permitted to a carbon tool working at the old speeds, will usually suffice. Peculiarities of form, or extreme speeds and exacting requirements as to quality of work, may occasionally necessitate even more metal.

In the first days of alloy steels, when unannealed stock was recommended and used almost exclusively, the tool holder, permitting the use of comparatively light stock and necessitating little waste, bade fair to solve the problem of keeping the first cost of tools of this class at the minimum. In fact, when so used, the first cost of such tools, considered on the basis of work finished, is almost without exception less than that of similar tools made of other materials. The criticisms that such holders and tools lacked the requisite stiffness was soon silenced by the appearance of heavier holders. They are now made so heavy and with such excellent arrangement for gripping the cutter that little remains to be desired in this respect. There is however one objection to their use which at present appears impossible to overcome, namely the inability of such a combined tool and holder to conduct away the heat generated in cutting, as rapidly as is necessary to permit working the tool at its maximum speed. Increasing the amount of metal in the holder does not wholly obviate the difficulty. The reason seems to be that the alloy steels are much better conductors of heat than carbon steels. When the one is combined with the other, the small piece of alloy steel is unable to get rid of the heat developed in cutting as rapidly as is necessary when working at a high speed, and is likely to be burned.

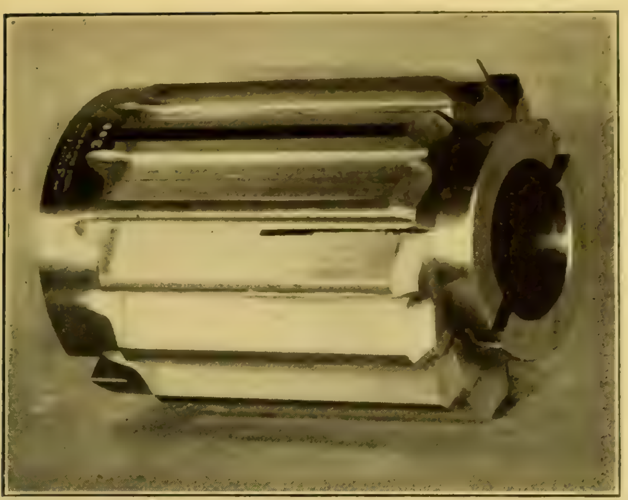
The same objection holds in the case of tools with a carbon-steel body having brazed cutters of high-speed steel. For some classes of work, as where the highest cutting speed is for any reason undesirable or unattainable, such tools serve as well as any others. But in general the highest efficiency will be attained through the use of a solid tool of alloy steel. Of course the first cost, in the case of heavy tools, is apparently large; but it has been already pointed out that the only fair comparison in the cost of tools must take into consideration the relative quantity and quality of work produced. A high first cost therefore does not necessarily signify anything, and good practice indicates the use of the solid tool.

The same considerations do not hold good to a like degree in the case of reamers and milling cutters having comparatively heavy cores. Here the danger of burning the cutting edges is less imminent. There is nevertheless another difficulty that often causes trouble, namely that of securing sufficient clearance for the increased amount of bor-



The Engineering Magazine

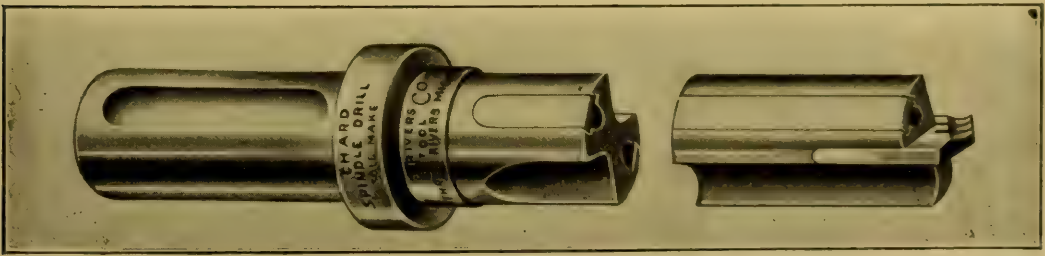
INGENIOUS AND HIGHLY SUCCESSFUL HOLLOW MILL, INVENTED BY MR. WALTER BROWN.



MATTHEWS FOUR-INCH EXPANDING-SHELL CORE DRILL.

Made by Three Rivers Tool Co., Three Rivers, Mich. Patent applied for. Alternate flutes slotted at cutting end. Expansion is effected by a locking taper plug.

ings or cuttings and at the same time providing sufficient backing properly to support the inserted cutter. The determination of a happy mean may involve the use of fewer cutters than the customary number. The position in which the tool works and the material operated upon, that is to say, the nature of the particular job, will have much to do with the ultimate form of the tool. Obviously, a reamer working vertically on a job where the borings are removed by gravity presents fewer difficulties than one working horizontally as is sometimes necessary; and the chief consideration here will be to secure the requisite strength. The backing of the cutter is not the only thing that needs to be taken into account. The rigidity of the latter, and consequently its ability to stand up under heavy duty, depends equally upon the firmness of its seating and its attachment to the core. Unless the cutters are so solidly attached as to be practically a part of the core, the tool cannot be depended upon for continued service. The difficulty of making such an attachment by mechanical means is evident. Many tools of this class have been designed, and a considerable number put on the market. Some of these, particularly those intended to be used as floating reamers for sizing, rather than for boring, do very well in all but the heaviest work. For such duty it



CHARD DEEP-HOLE SPINDLE DRILL.

The Interchangeable double-lip cutting point is held in place by a taper pin. Made by Three Rivers Tool Co.

seems to be pretty well established that the cutters should be brazed or welded to the core.* Such a treatment gives the effect of a solid tool possessing the disadvantage of low heat conductivity but otherwise equally as good as one made entirely of alloy steel.

In the case of most milling cutters there is more room for attaching the cutters by mechanical means, so that there is apparently less advantage in brazing the cutters than there is in the case of reamers. On the other hand, there is a distinct advantage in mechanically attached cutting blades in that the same core may be used an indefinite number of times, it being necessary only to replace worn-out cutters with new ones. This obviously applies more particularly to the larger sizes of tools. Where it is necessary or desirable to use them of small diameters, the increased number of cutting edges possible to a solid tool gives that form a distinct advantage over the other in the amount of metal removed per revolution. The danger of overheating is small because only a few of the teeth are cutting at the same time, the remaining ones meanwhile being exposed to the air and cooling.

The difficulty of hardening solid tools of this class is also to be taken into consideration. It has been shown that such cutters, more especially when of large diameters, are very susceptible to flaws and cracks during the hardening process—cracks which often become manifest only when the tool has been put at work—sometimes long after. All things considered, the best practice seems to be to use inserted cutter tools in all sizes large enough to admit of its being done. Small disc and irregularly shaped cutters are obviously better made solid.

As to the mode of attaching mechanically held cutters to a core or body, it is safe to say that screws are in general to be avoided. The reason is pretty well understood among tool designers and users—namely the tendency of threaded parts to work loose and to require frequent replacement by new and over-sized ones. The materially increased cost of manufacture is also a consideration. Properly doweled insertions, fitted under pressure sufficient to insure solidity, are about as good as brazed cutter tools, whether they be of the reamer or miller type. In the latter case, and in reamers whose blades can be ground so as to leave the core intact, the cost is lessened by the repeated use of the same body with new sets of cutters. It is often possible in this way, even if the core be used but once, to make them at less cost than that of similar carbon-steel tools. The cost of

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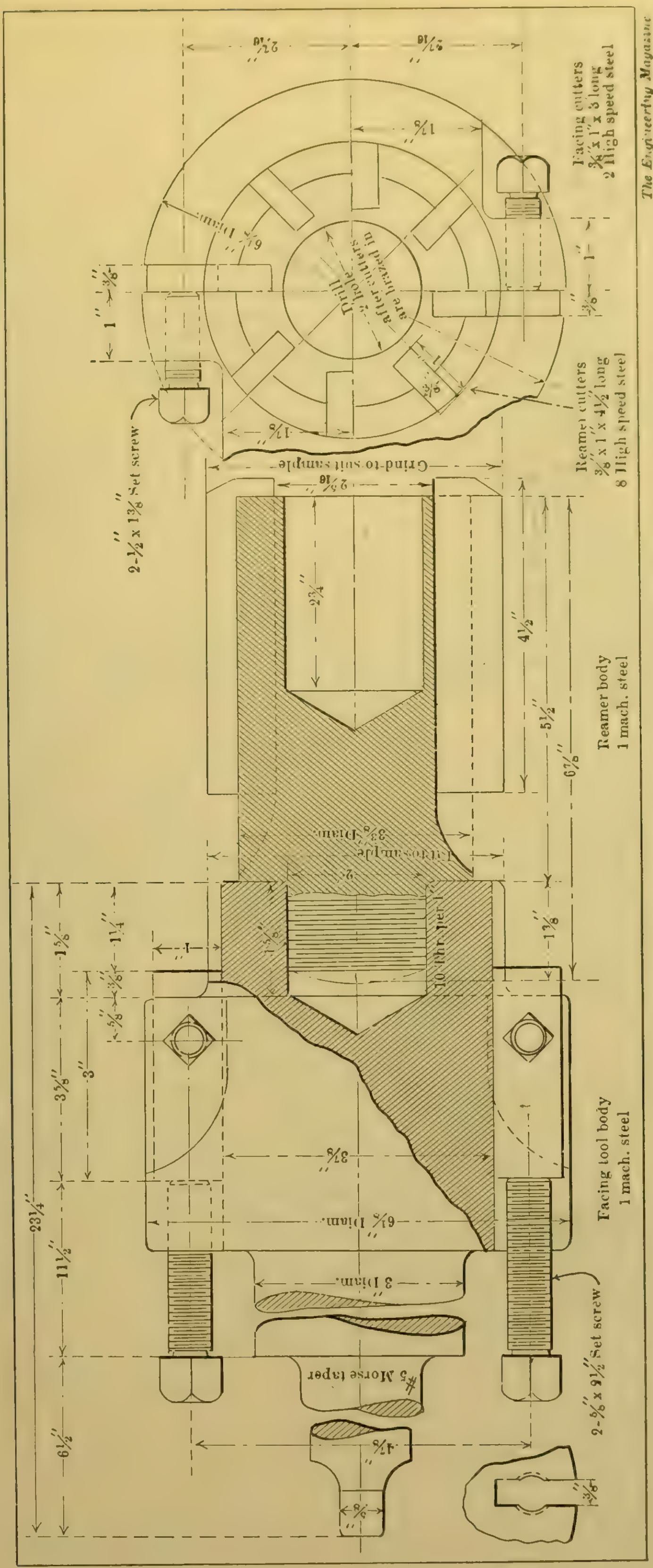
* The writer would be glad to learn of the experiences of others in welding high-speed cutters to carbon-steel bases and cores, particularly as regards the use of Thermite.



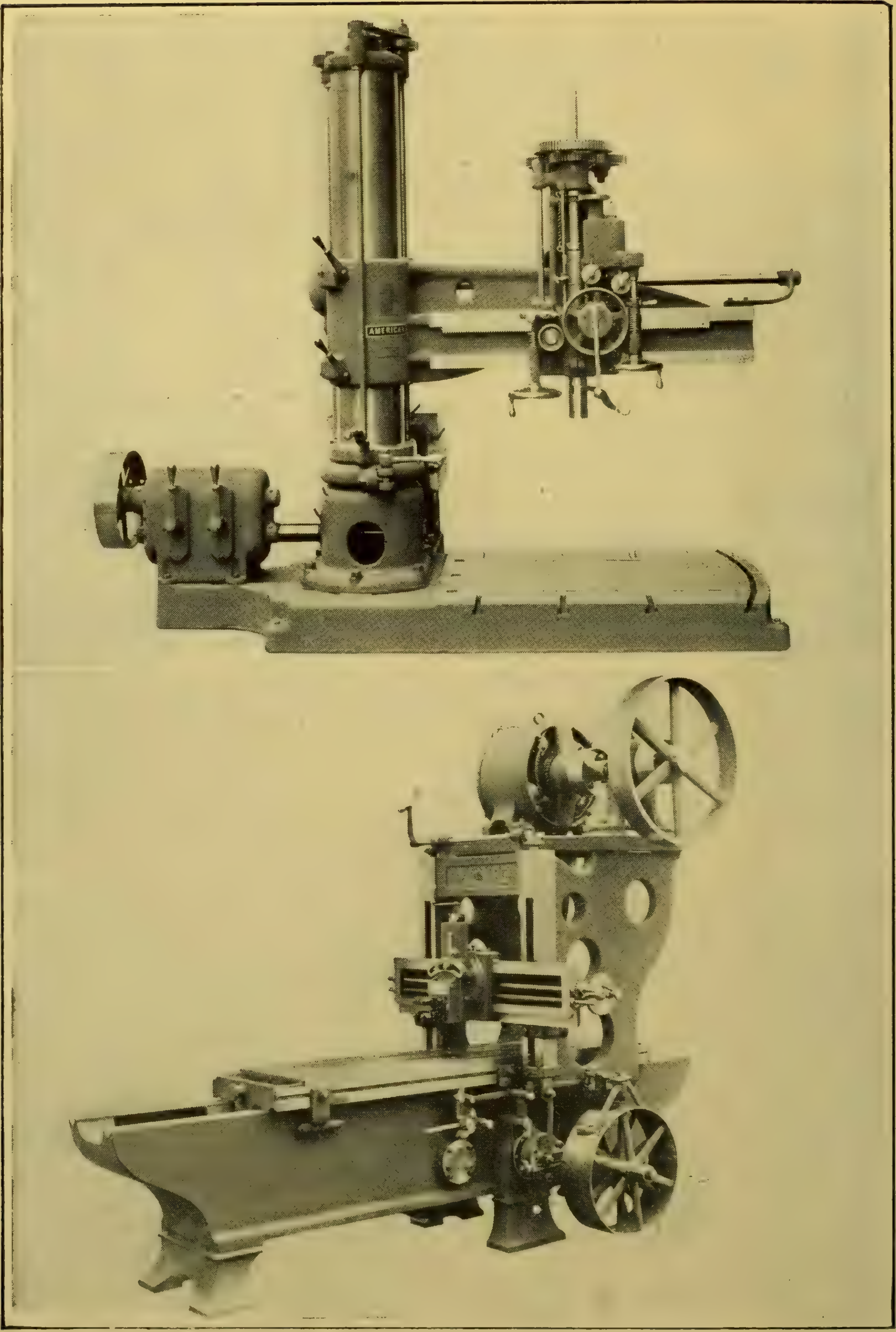
The Engineering Magazine

COMBINED REAMER AND FACING TOOL, INVENTED BY MR. WALTER BROWN.

tools with brazed cutters is obviously less than that of the other types and it is not uncommon that the first cost, tool for tool, is less than that of the solid carbon-steel type.

The cores in tools of this class may be of any ordinary steel. Open-hearth has been used in some instances with satisfactory results. If the strain be very great, however, as in the case of long reamers or reamers with shanks smaller than the body, the safe course is to use a good quality of crucible steel. Even when so made, such tools have been known to twist off under exceptionally high duty.

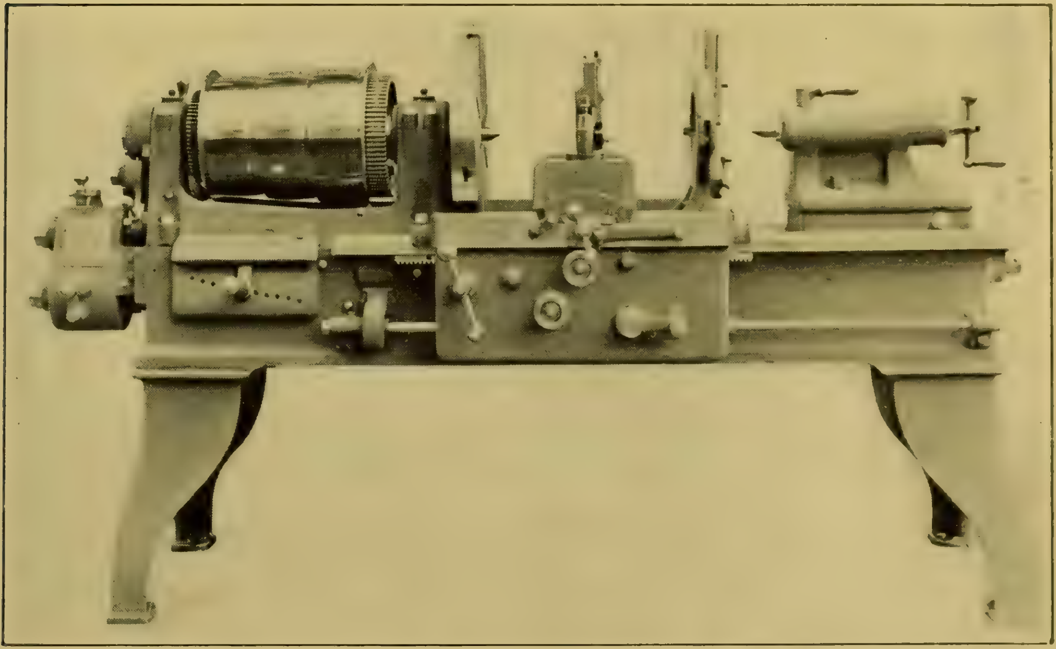
Such tools as reamers and core drills are in certain respects a class by themselves. There is but one way in



SOME MODERN RAPID-PRODUCTION MACHINE TOOLS.

The upper figure shows a plain radial drill with speed-box drive (same as geared head), with ample strength for high-speed work. The lower picture represents a small but heavy planer, motor-driven, with fly wheel to relieve the severe strain in reversing. Both built by American Tool Works Co., Cincinnati, O.

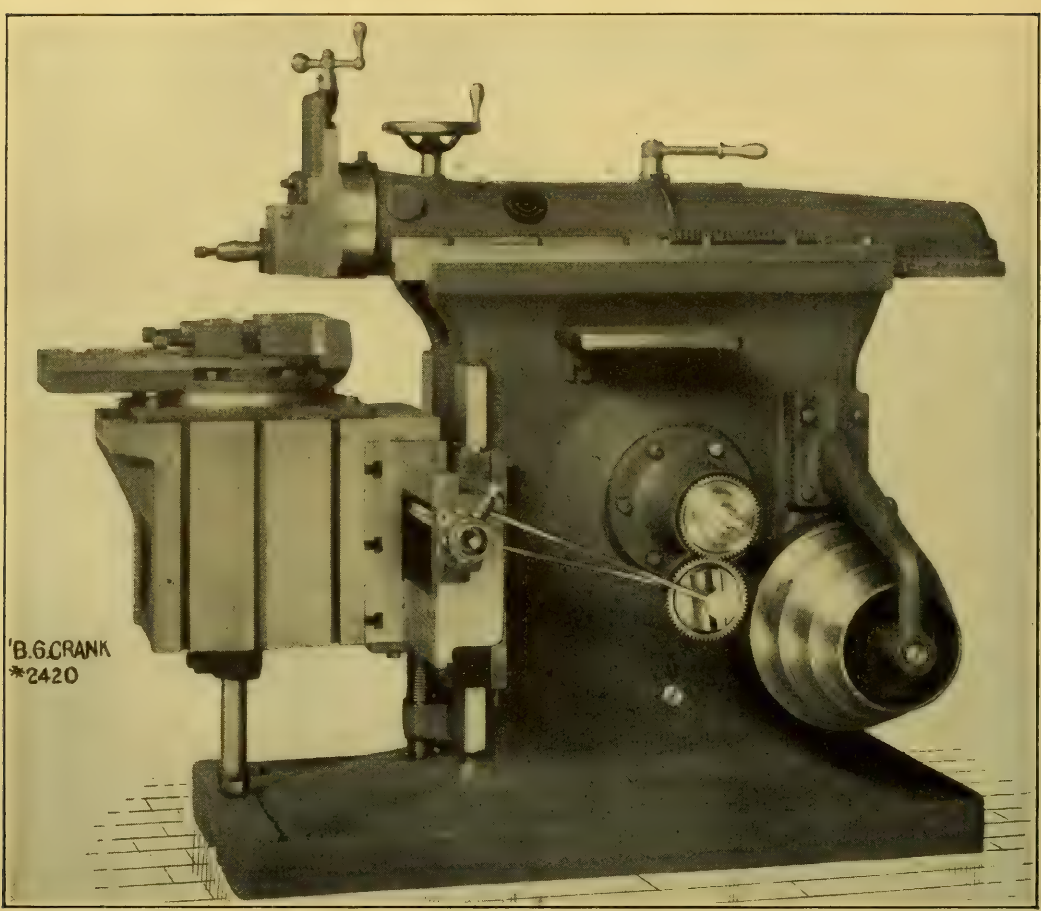
which their work can be kept between the required limits of precision, and that is to keep the size of the tool also within the limits. Now there is always some wear to the sides of cutters, as well as to the cutting edges, so that unless the cutting point be ground back far enough to pass the worn part from time to time, the size of hole gradually becomes smaller and the tool duller—and reciprocally, as the tool dulls more and more the wear increases correspondingly. Of course, the use of high-speed cutters makes such variations in accuracy very slow; and in some shops the matter is considered of small consequence. In other cases, however, it is of considerable importance, and it is desirable to minimize the trouble as far as possible. Expanding tools have therefore come to have a proper place in a shop equipment. Several types have been brought forward, most of them involving the use of mechanically held cutters and taper plugs of one sort or another.



EIGHTEEN-INCH LATHE DESIGNED FOR THE HEAVIEST WORK AND HIGHEST SPEEDS.
American Tool Works Co., Cincinnati, O.

A recent design that gives excellent results and stands up well under heavy duty, has a hollow core slotted at intervals, and the usual taper plug for expanding the cutting end only.

Respecting the design of twist drills little can be said as yet. They are intended mainly for small work, and necessarily their form as developed in carbon steel has come to be about all that could be expected, so that in high-speed steel it will be pretty safe to follow the established lines of design. A recent innovation that will certainly result in a

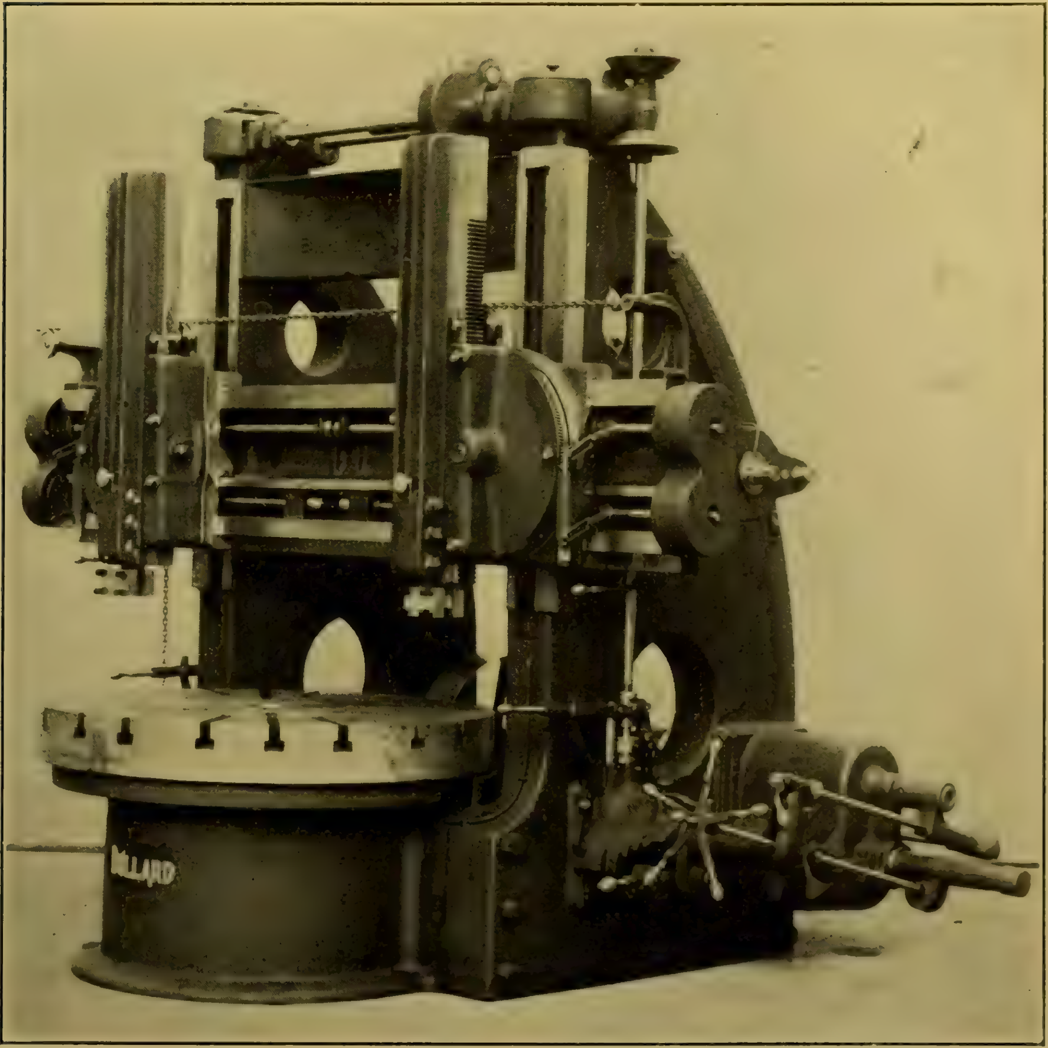


TWENTY-FOUR-INCH "CINCINNATI" HEAVY-DUTY CRANK SHAPER.

Column of unusual width and depth, ribbed and braced internally; ram with wide and long bearing; rail deep, heavy, ribbed horizontally and strongly gibbed to column. Cincinnati Shaper Co.

greatly reduced cost in twist drills is the introduction by one maker of high-speed steel, of a rod rolled with a fluted section of suitable proportions so that when twisted to the desired pitch it has the standard twist-drill form. Ground to size and cutting edge, and provided with a suitable shank or holder, the drill is complete, at a surprisingly small cost. That these drills are in all respects satisfactory is evident from the fact that they are used almost exclusively by one of the largest manufacturing concerns in the country. The same maker also rolls sections suitable for making other tools in a similar manner.

An important element in tool design—one that does not usually receive the attention it merits—is the angle to which the cutters are ground. It is not unusual in shops said to be pretty well managed to grind tools without much regard to the angle, and quite certainly without regard to the material on which they are to be used or the diameter of the finished piece. It does not appear that reliable data have as yet been found experimentally upon which to base cutting angles for high-speed tools, though in several quarters experiments have been begun with a view to determining the reciprocal relation of angle to material, speed, feed, depth of cut, and (in the case of rotating pieces) the diameter of the work. Much of this information is already available as regards tools working at ordinary speeds; but there seems to be good reason for believing that at the high speeds possible with the new tools somewhat different angles will tend to greater efficiency. The investigations lately undertaken by Prof. Breckinridge at the University of Illinois School of Engineering should be watched with interest by tool designers.

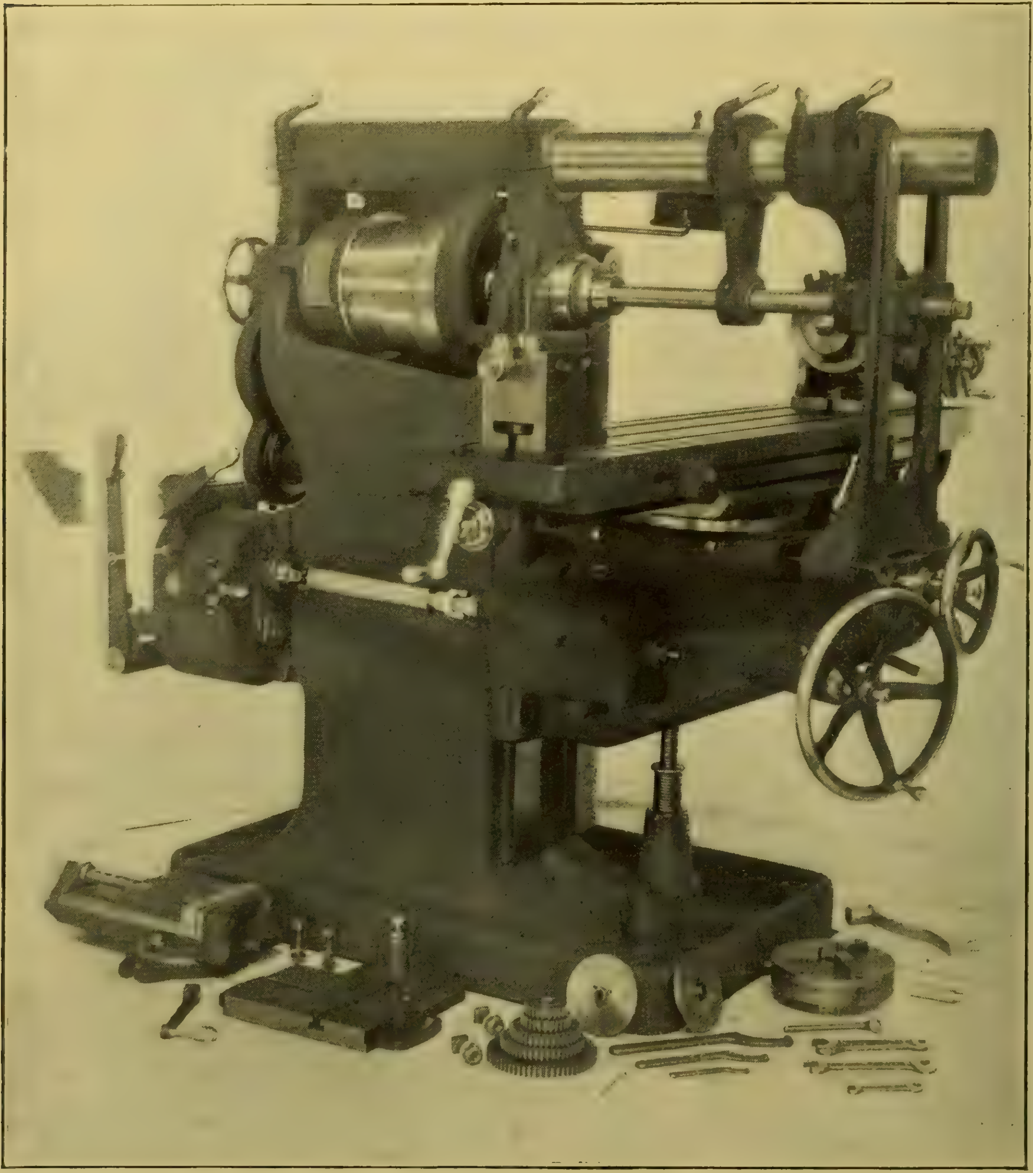


BULLARD FIFTY-FOUR-INCH RAPID-PRODUCTION BORING AND TURNING MILL.

Driven from constant-speed shaft, with fifteen changes by speed-box; headstock and speed-box entirely enclosed, with splash system of lubrication; gears running in continuous bath of oil; ring or chain oiling for all high-speed shafts.

Bullard Machine Tool Co.

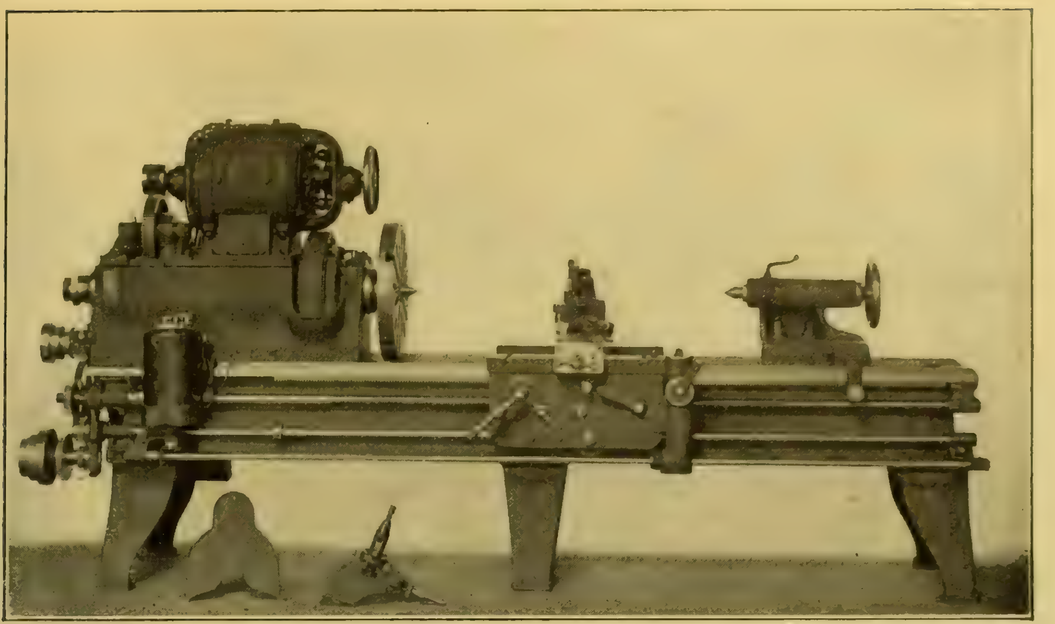
Thus far in the present discussion only cutting tools have been considered. The usefulness of alloy steels for such tools as dies, punches, and shears is demonstrated as unquestionably as for the cutting tools. As a matter of fact, however, comparatively little use these purposes, perhaps for the has as yet been made of them for



UNIVERSAL MILLING MACHINE FOR MODERN HIGH-SPEED PRODUCTION.

Special features adapting it to rapid production are the unusual width of driving belt, large diameter of driving cone, positive gear drive, and generally heavy and well proportioned design. Becker-Brainard Milling Machine Co.

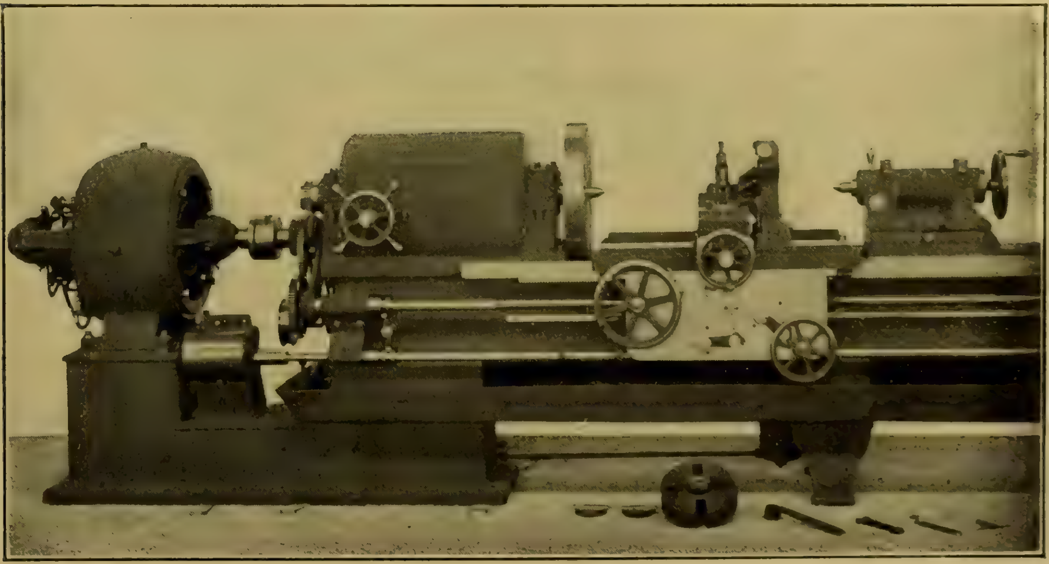
reason that the chief effort of makers of high-speed steels has been directed to the perfection of their product for cutting tools, and in consequence the difference in efficiency between carbon- and alloy-steel shear blades and punches is not so marked as in the case of the



TWENTY-INCH ENGINE LATHE OF RECENT DESIGN.
Made by F. E. Reed Co., Worcester, Mass. Variable-speed motor and speed-changing gears.

other class of tools. The advantage is obviously in the longer life of the tool and not in any increased speed of production.

No particular variation from the accepted forms has been found necessary for punches of alloy steel. And since the amount of metal required is comparatively small, no attempts have been made, so far as reported, to combine an inexpensive body with a high-speed-steel cutting face. Some successful combinations of this sort have been used for cutting-off shears, and there is no apparent reason why tools

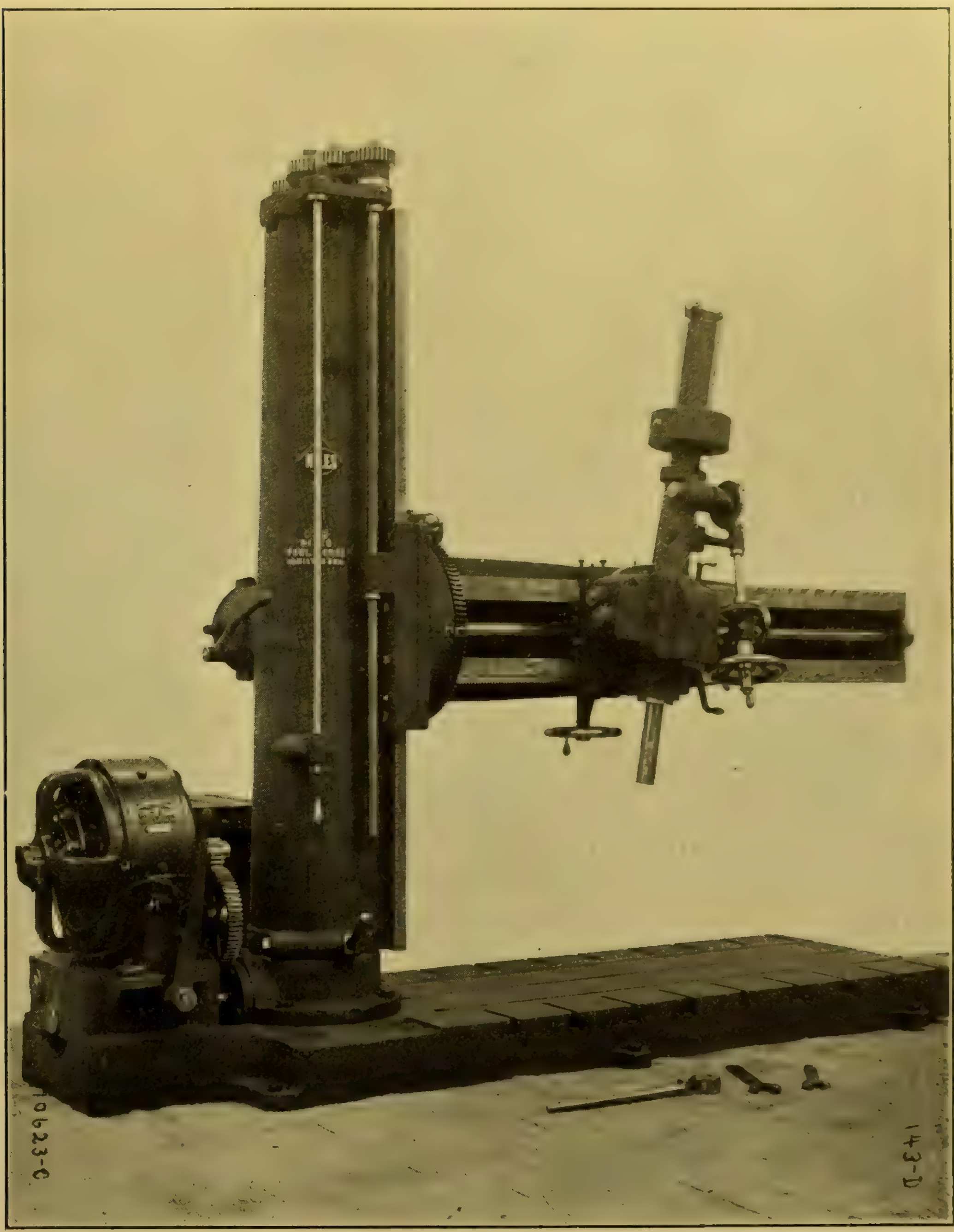


LODGE & SHIPLEY HIGH-SPEED LATHE, DIRECT MOTOR-DRIVEN.
Lacking some of the traditional lathe features; motor armature connected to main gear shaft; speed variations by gears and variable-speed motor.

of this design should not be largely used. Punches having relatively large cutting-face areas would come into the same category.

Some use has been made of the high-speed steels for dies, usually designed upon traditional lines. It is a matter of surprise that high-speed steel is not more commonly used for dies subject to excessive wear. They are but little more difficult to make than others, and their life is out of all proportion to the increased cost.

Much has been said within the short time that high-speed steels have been in use respecting the machine requirements of the new *régime*. Manufacturers of both carbon and alloy steels say that they are systematically reducing their stocks of the former and increasing those of the latter, to conform to the changing trade demands. A logical inference would be that the machine-tool market would be sympathetically affected, and workshops begin to be equipped with machines designed with particular reference to obtaining the highest possible degree of efficiency from the new tools. Visits to factories and selling agencies are however sadly disappointing in this respect. Apparently managers of producing plants are in the main still content to use up their old equipment. For example a large plant employing some ten-thousand men, whose output involves about the maximum in repetitive work, has not as yet installed a single machine that is capable of using high-speed tools to their limit. Neither are any considerable number of the machines in use adapted to secure best results. A few new machines of somewhat heavier type than those previously bought have been installed, and old machines merely speeded up a bit and used at an efficiency usually much below even their present capabilities. In a recent visit to practically all the large selling agencies in Chicago less than half a dozen machines of any type were found in stock that would fulfil even very moderate up-to-date requirements. Any number of the old familiar types could be seen, a few of them slightly modified to the extent of some increase in weight of frame. or bed. In most of these, even, there had been no provision for any considerable increase in power, the narrow, many-stepped cones of the ancient yesterday being very much in evidence. A glance through the advertising pages of periodicals devoted to the machinery trade likewise emphasizes the curious conservatism of buyers and makers of machine tools in this respect. It is true that some machines have been made and installed capable of driving high-speed tools to the limit. Usually, however, they have been used for special purposes; and leaving out of consideration the tendency to increase weights. there seems to be little evidence that there is as yet any general move-



A POWERFUL SEVEN-FOOT RADIAL DRILL, DIRECT MOTOR-DRIVEN.
Made by the Niles-Bement-Pond Co.

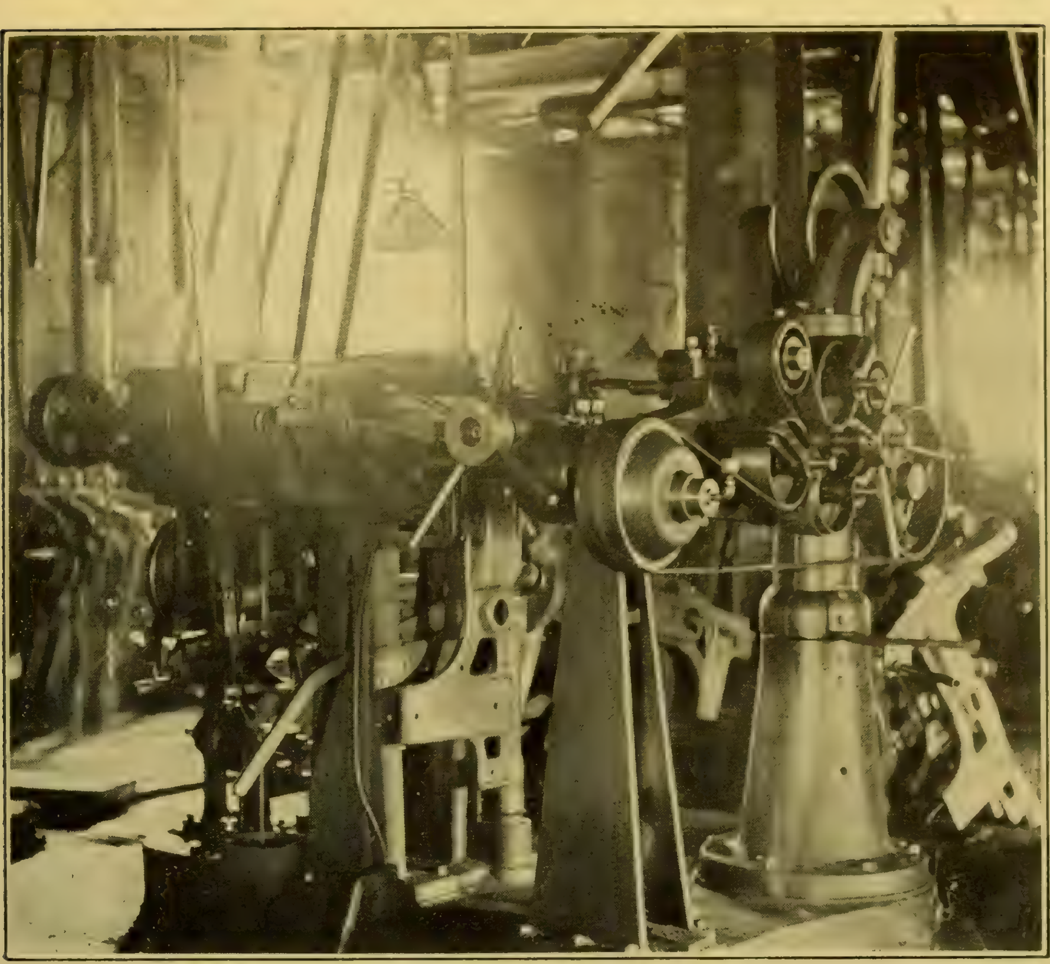
ment looking toward the substitution of machines of a type in any essential regard different from those put out during the past ten years. An inquiry into the design of machines for use with high-speed tools therefore should take into consideration the adaptation of present types as well as the determination of new ones of greater efficiency.

Just what can be done with a machine of the usual type, say a lathe, is not easy to determine off-hand. Most manufacturers do nothing but speed it up a bit by using the smaller cones more freely, and possibly by adding somewhat to the feed, when using high-speed tools. The average bed is strong and rigid enough to stand more of this than the belt will pull, on short stock at any rate if not on long. An obvious expedient, as pointed out in a previous paper, would be the substitution of cone pulleys with wider faces. Very likely such a modification would suggest the further advantage of discarding the head altogether and using a new one designed with heavier bearings. This is feasible in many instances when the lathe is used for general manufacturing in repetitive work held in jigs, where there is ordinarily nothing to a head but bearings, shaft with cone pulleys and center, and face plate. In the regular engine lathe or turret machines the expense of such a modification would be prohibitive. If the bed lacks rigidity, of course the matter is ended so far as that machine is concerned.

Many machines in general manufacturing shops doing much jig work were designed to take the heaviest work probably to be done in the shop, and are therefore much heavier than required for most of the work done on them. In such cases no modifications will be necessary beyond adaptation of countershafts and possibly driving cones to the heavier pulls and higher speeds.

Now what are the fundamentals of design as affecting machines expected to develop the highest possible efficiency?

Before attempting an answer to this question it is pertinent to point out that this discussion will be looked at from very different viewpoints by the two classes of machine users to whom it might be expected to be of interest. The requirements of the shop doing little but the reduplication of pieces in great numbers which need be "good enough" only, will be very much simpler and perhaps less exacting than those of the general jobbing shop where a machine may be called upon to perform a great variety of work. In the former the use of the jig and similar devices to hold the piece operated upon and to guide the tool, for a large proportion of the work, makes possible a satisfactory use of machines fulfilling but two requirements: strength and power to pull the work. Even extreme rigidity is not usually necessary in this class of work, though by no means undesirable. The small range of work done on any machine not only eliminates the need for any considerable number of speed variations, but actually makes such a variety something of a nuisance. Furthermore, for work of this nature the highly specialized machine is coming to be more and



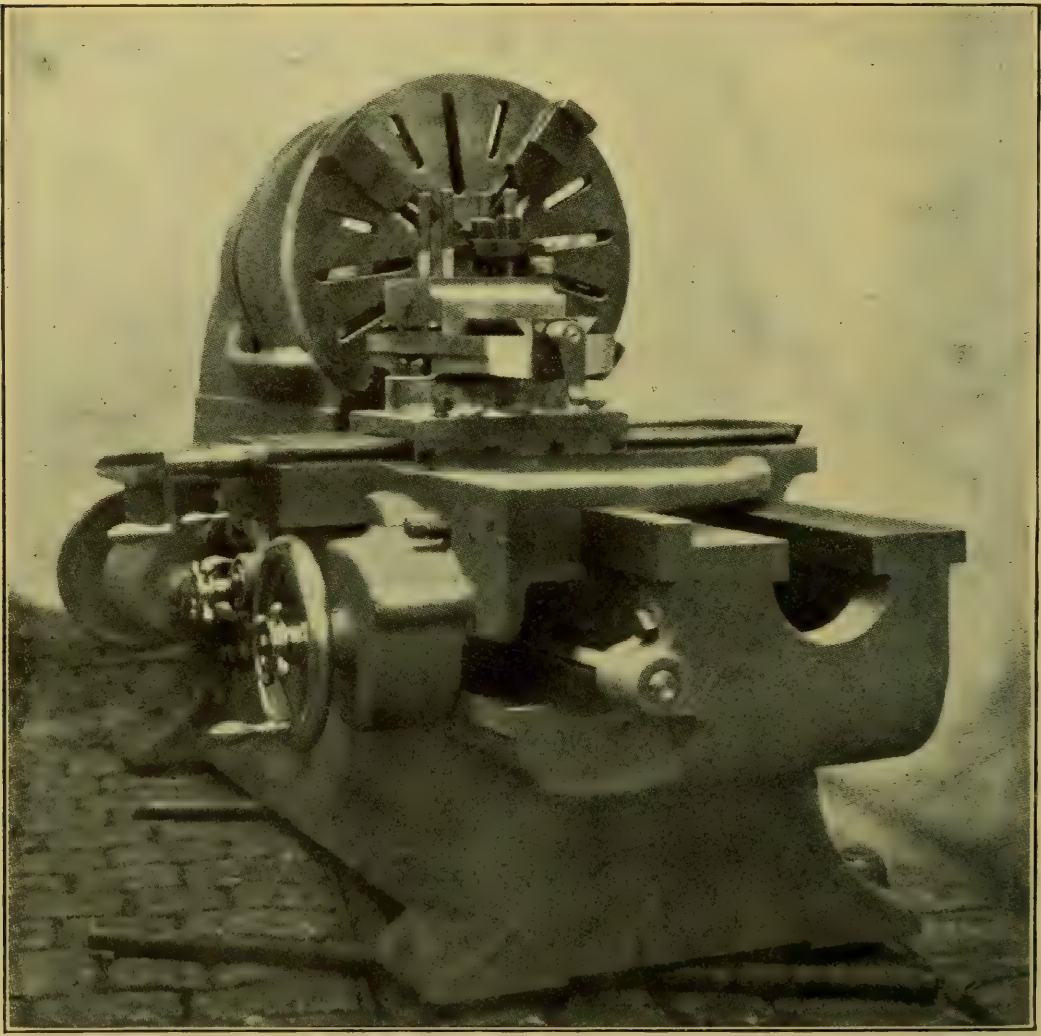
A VERY HIGHLY SPECIALIZED MACHINE, DESIGNED FOR SPEED AND POWER.

Eleven high-speed drills operate on a special casting from both sides simultaneously. No other job is done on this machine.

more used, its work being limited (for the sake of the highest possible efficiency) to a single piece, or at the most of a few very similar pieces. For all such a single speed is all that it ever used.

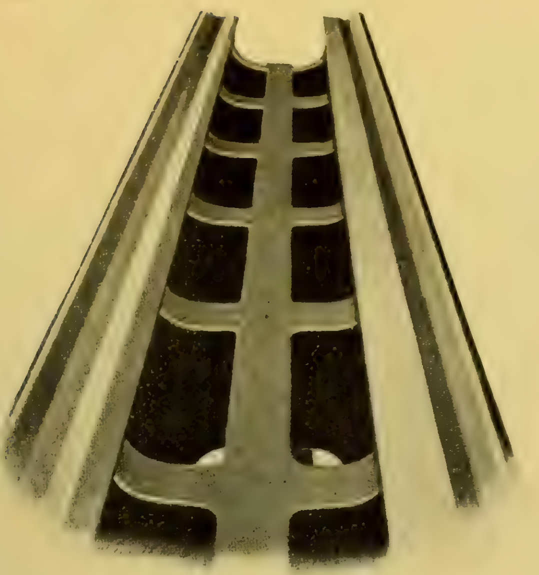
Manifestly the shop turning out a few pieces only of a kind, and doing a great variety of work, whether it be the tool room of a big factory, the general manufacturing shop, or the small jobbing shop, requires a very different class of machine. Since jigs will be little used and usually precision must be obtained by accuracy in the machine, there will be the additional requirements of great rigidity, adjustability, and speed variability. In the following discussion the latter class of machines has been most prominently in mind, though much of what is said applies with equal force to the former.

Much has been said and not a little written about the so-named "anvil" as opposed to the "fiddle" principle. The gist of it all appears to be that solidity, that is to say weight, is the prime essential. Of course mass does create inertia, and likewise rigidity. The proper distribution of material however is more important than the amount of it. It is well known that the hollow cylindrical form of construction is stronger in every way than the solid, for the same weight of material, and this principle is made use of in many ways—in nearly every way, one might almost say, except the construction of most types of machine tools. The lathe bed, for instance, still is of the traditional type, namely two I beams housed at the ends and usually stayed by cross girts; and makers are clinging to this form with all the tenacity of a dogged conservatism. It has been shown experimentally (by Professor John E. Sweet, if memory serves aright) that a four-sided box is more than twelve times as rigid with respect to twisting strains



A GOOD EXAMPLE OF ENGLISH LATHE DESIGN.

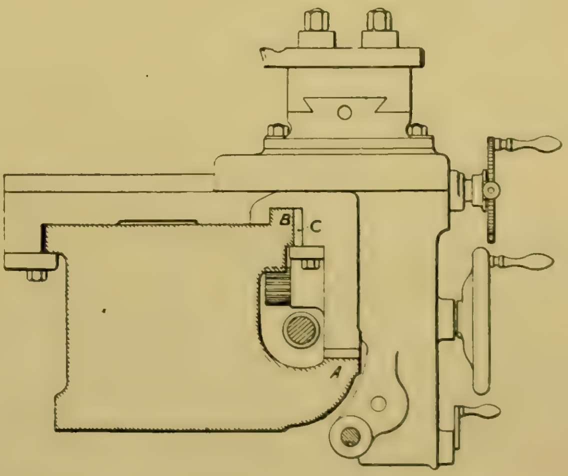
Made by Darling & Sellers, Ltd., Keighley. Double-tier bed with projecting ledge.



LATHE BED USED ON LODGE & SHIPLEY MACHINES.

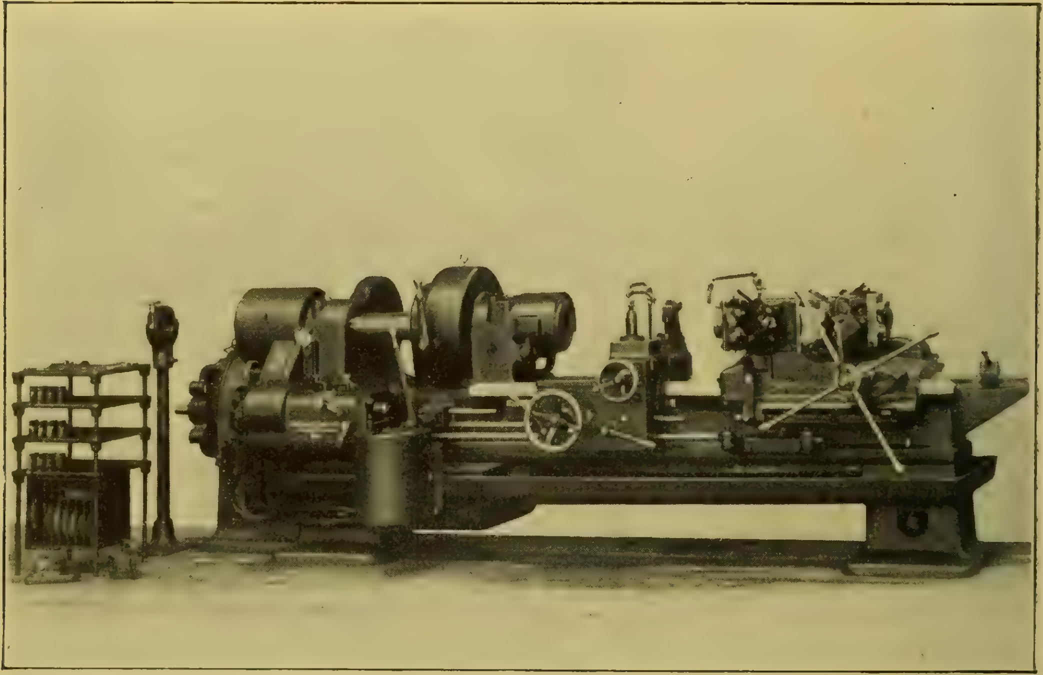
as the same amount of material in side plates with cross girts of the usual proportions. The best possible distribution of material in this form (beams and girts) does not reduce the disproportion more than half (see the diagram on page 409); so that the very best design of lathe bed on conventional lines would have anywhere from one-fourth to one-eighth of the strength it might have were the material distributed in the four-sided box form. Now the chief business not only of lathe beds, but of the frames of all machines designed for rotating work or tools, is to resist such twisting strains; and it might seem that designers would seize upon so simple a mode of saving metal, or rather of getting the maximum strength out of the metal used. As a matter of fact, however, machines of such design are almost unknown—in the United States at any rate. One American maker is said to make a lathe with such a bed, and at least one English manufacturer also approximates the box form. In multiple mills, planers, and lathes, beds and frames or rails having a three-sided (that is, three of the four sides of a box) section are not so uncommon, but this form is scarcely so strong in resisting torsion as the regular type, and only about a tenth as strong as if part of the metal used were distributed so as to make a fourth side.

Next to the body of a machine in importance is the head. Obviously it ought to be in strict proportion with the former. It needs strength and rigidity (and certain other qualities as well)—just as



SECTION THROUGH DARLING & SELLERS LATHE BED AND CARRIAGE.

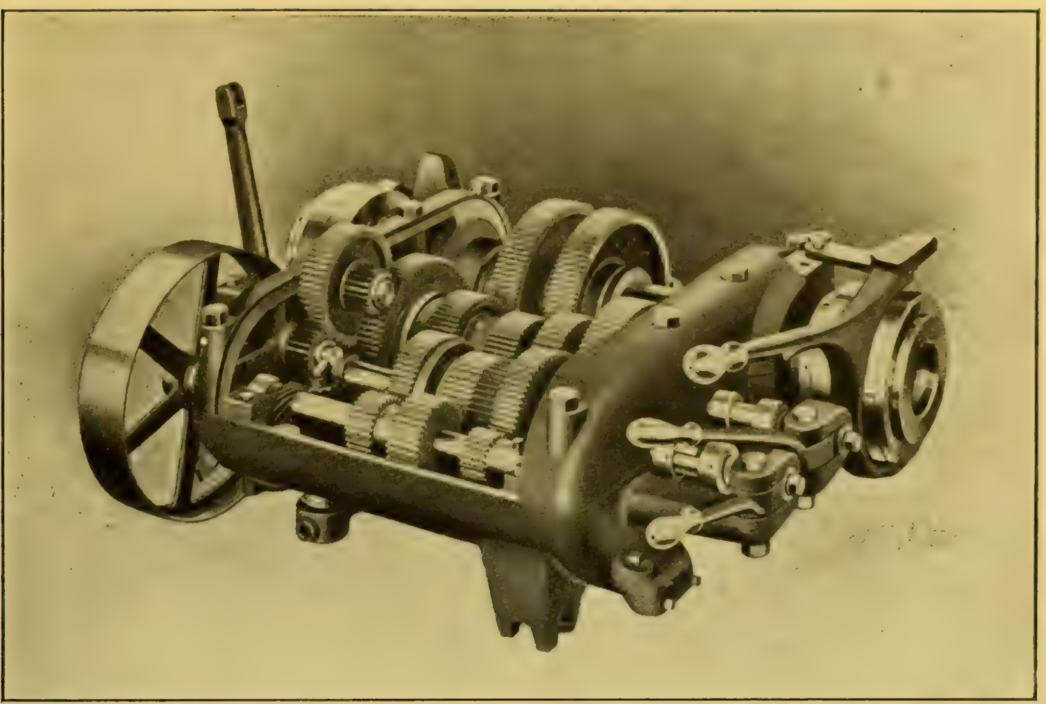
much as the body does—but no more. Certain makers have taken to putting abnormally heavy heads upon regular machines, more particularly lathes, and offering them as up-to-date high-speed machines. These megacephalous monstrosities ("hydrocephalous" somebody has dubbed them, possibly in reference to their designers rather than to the machines themselves) doubtless serve a useful purpose. There is however no more reason for putting a tremendous head on a machine without a corresponding modification in other respects than there would be in using a big tool without proper support. The head of the new machine will doubtless be larger, and certainly heavier than heretofore, not alone to give additional weight, but to admit of modifications in bearings, and mode of driving.



WARNER & SWASEY CO. HEXAGON TURRET LATHE.

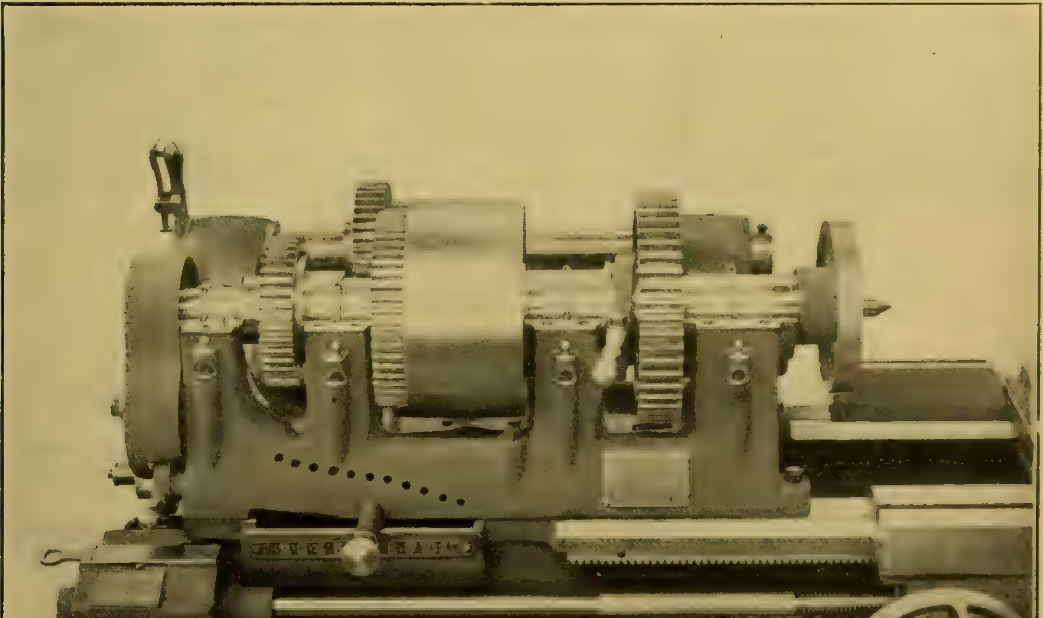
Known as their "No. 3." Head and bed cast in a single piece; direct-connected motor drive; flat turret carriage.

Rigidity and strength being the watchwords of the coming *régime* in machine-tool design, it is pertinent to inquire how this end is best subserved in the attachment of head to body. Except only in a few machines of special design whose utility lies in the range of work of which they are capable by reason of movable and adjustable heads, the driving heads are stationary and bolted to the frames or beds as rigidly as possible. Now if the contiguous faces are sufficiently large, the bolts heavy and numerous, and a good cement used on the faces, an attachment can be made that will be exceedingly rigid. But no amount



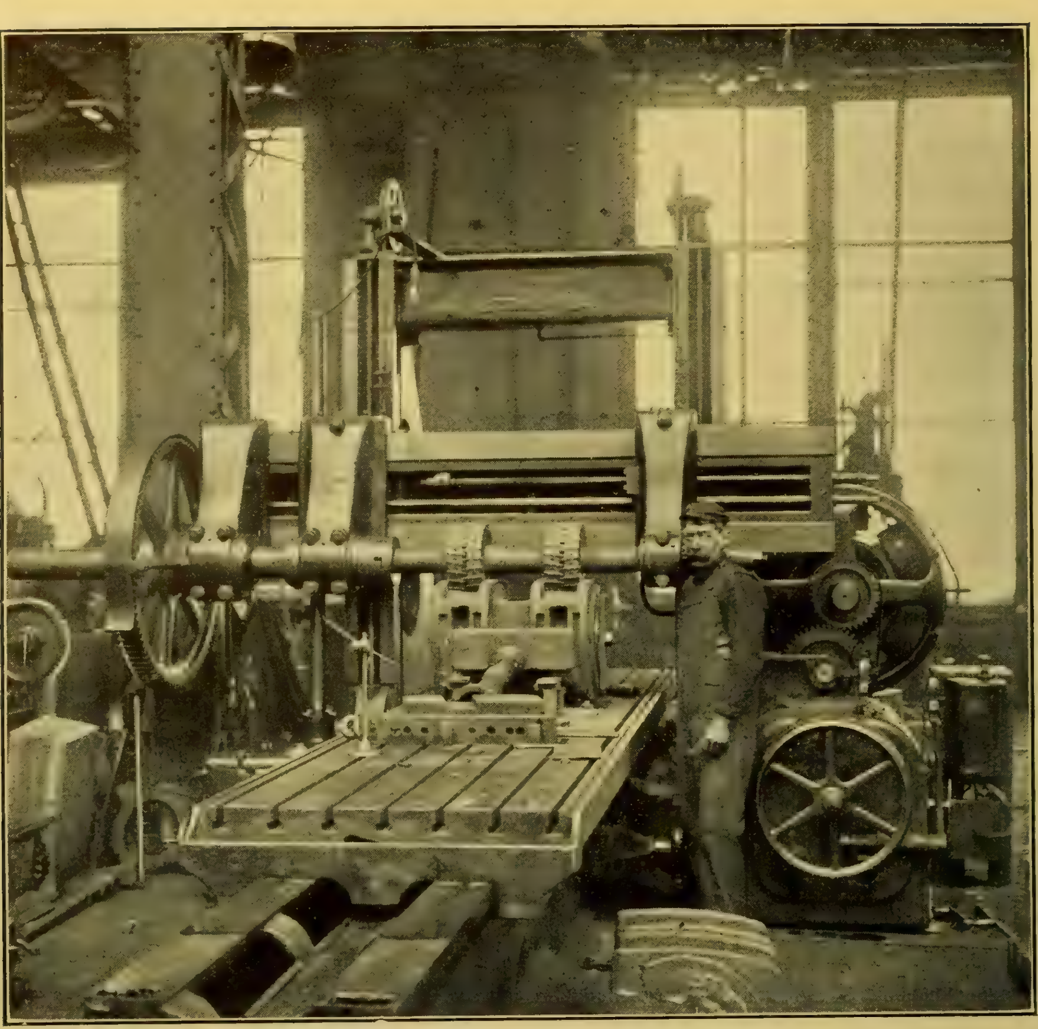
HEADSTOCK OF JONES & LAMSON FLAT TURRET LATHE, WITH COVER REMOVED.

All shafting and gears in a horizontal plane and half-submerged in oil. Single drive pulley and self-contained speed-changing device.



"PATENT HEAD" OF LODGE & SHIPLEY HIGH-SPEED LATHE, WITH CAPS AND SPINDLE REMOVED.

Belt-driven, through a single wide-faced pulley; speed changes secured by gears and countershaft; positive lubricating device.

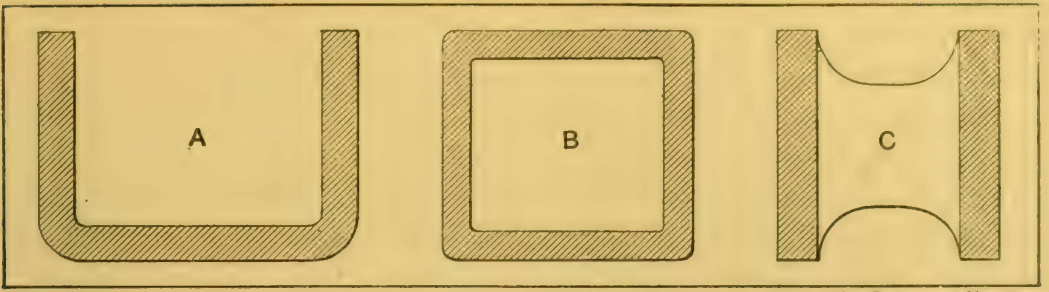


AN EXAMPLE OF MODERN MILLING-MACHINE PRACTICE.

Forty-eight-inch Bement horizontal milling machine at work milling shoe and wedge grooves in driving boxes, Angus shops of the Canadian Pacific Railway. Made by Niles-Bement-Pond Co.

of bolting can take the place of continuity of structure; and it would seem that a head cast in one piece with the frame would be most desirable for high-duty machines. At any rate some builders are accepting the principle in their latest productions, and others are seriously considering doing the same, in spite of the considerably increased foundry and machine-shop cost.

Properly proportioned main bearings are much more important under the new order of things than formerly. Not only is the highly increased speed of the driving spindle to be considered, but also the very large increase in pressures. To meet these conditions bearings require greater surface. It is preferable to have the augmented surface result from increased diameter rather than from length on account of considerations of space as well as rigidity. Such an arrangement



VARIOUS DISPOSITIONS OF EQUAL AMOUNTS OF MATERIAL IN STRUCTURAL SECTIONS.

C is girded at intervals. B has 10 times the torsional resistance of A, and from 6 to 13 times that of C, the precise ratio depending on the strength and frequency of the girts.

permits also the use of hollow driving spindles, which again tends to greater strength and permits the better use of gears in the driving mechanism. In ordinary machines the matter of lubricating the bearings is not troublesome. Under the new conditions it is not so simple however, as everyone knows who has used a standard machine at high speeds. The tremendously increased friction makes it necessary to provide free and certain lubrication for the bearings and therefore involves the design of special lubricating devices for this purpose. A successful arrangement of this sort is shown in one of the illustrations. Oil is stored in a well with which the bearing is provided, and is dipped and carried in sufficient quantity to the highest part of the spindle at every revolution. Glass tubes inserted in front and properly protected serve as level indicators. Another satisfactory device, also illustrated, consists in arranging all shafting and gears in a horizontal plane in a shallow covered pan, allowing all to be at least half submerged in oil.

The tail stock of a lathe used for work turning on centers is little less important, if any, than the head stock, though usually it seems to be little considered. The base is usually rather short, and often it lacks weight. For high-speed work it is more than desirable that there be some provision for positively bracing it against the bed. Obviously the center in the tail stock should be of high-speed steel.

The more joints the less rigidity. Heretofore much attention has been given to securing a great variety of adjustments in the mechanism used for holding and applying the tool to the work. The result has been that slide rests and devices of similar purpose have been constructed of many pieces and a multiplicity of motions. These may have been well enough suited to former conditions; but they certainly are not to the new ones. Rigid support of the tool is vital to its own life as well as to the excellence of the work it does. If there is spring enough to allow a tool taking a fine cut to ride over the work to the slightest extent, the tool rapidly dulls and refuses to do its work. If on the contrary it is held up rigidly so that the chip takes its proper course, the tendency will be to wear a slight concavity behind the cutting edge and the tool thus be constantly sharpening itself. Be the frame ever so stiff, if the tool rest and its adjuncts permit of vibration, it avails little. Now vibration in cutting is not necessarily perceptible. It might be, and indeed generally is, supposed that absolute rigidity has been obtained if no chattering or vibration can be felt. As a matter of fact however there is no such thing as absolutely preventing vibration in a cutting machine. The most that is ever done is to reduce it to a minimum: that is, to such a point that the work turned out is of the required degree of precision. Often when the operator supposes the machine to be cutting with great ease and smoothness there is really enough vibration seriously to affect the endurance of the tool, if not the required accuracy of its work. To obtain such freedom from vibration the tool-holding and applying device should be of the fewest possible parts, wide base, and least permissible altitude from points of support. That it should be heavy goes without saying.

When cutting speeds are moderate and chips correspondingly easy to care for, these latter cause no concern. When however they come off so fast, as was the case in certain tests made some time ago, that the machine operator needed to exercise a good deal of agility and caution to avoid being tangled up in and burned by the hot chips and two men were kept busy keeping the machine clear, the question cannot be disregarded. The case mentioned was of course an extreme one; but even so it points out one of the limitations which conservatism in machine design imposes upon the performance of the new tools. The removal of several hundred pounds of cuttings in an hour, as is not uncommon, clearly indicates the necessity for some suitable means to collect and take care of them. There is no inherent difficulty in the way of doing so, and in many cases it will be necessary to do it in order to get to the highest limit of efficiency in tool and machine. Nobody seems as yet to have thought enough about this feature of the general problem seriously to attempt its solution by devising a suitable arrangement for mechanically conveying such cuttings away.

The momentum of machines of this class is so great that they usually continue running for some time after the power has been disconnected. It is therefore very desirable that they be provided with some effective form of braking apparatus.

The driving of the high-speed machine presents a number of problems also. The many-stepped cone pulleys of the past are manifestly impossible for lack of room. Neither are they otherwise desirable. The higher speeds imply not only broader but swifter belts; and changing a rapidly running belt from one cone to another is both difficult and dangerous, unless indeed the difference between the steps be very small—which only complicates the problem again by further multiplying the number of cone steps. The single drive pulley and the variable-speed gear box seem to offer the best solution for the problem. The convenience with which the motor drive can be substituted for the belt, where the latter is not insisted upon, adds greatly to the practicability of gears for speed variation. The difficulty presented in finding space for a sufficient number of gears to give the required range of speeds is not so great as might be supposed. The high-speed tool allows so much latitude in speeds that there is no longer (if indeed there ever was) any necessity for a great number of speeds on a machine of a given size. Furthermore, the tendency is to specialize more than ever in the use of machine tools, so that the range of speeds required of any one machine need not be considerable. At any rate the use of a variable-speed countershaft or motor in connection with (say) about three speeds in the gear box, will give a range of speeds amply sufficient for most machines.

Objection may be made to the use of gears that they are too positive and in heavy pulling liable to breakage. Gears have already practically superseded belts for pulling the feeds in the ordinary type of machine and the same objection could be made to the use of gears for this purpose, for the strains on the feeding mechanism are as great proportionately as on the drive. The use of steel gears and possibly shearing pins obviates any difficulty on this score that might arise from objectionably large iron ones.

The advantage of the individual motor drive for machine tools is coming to be pretty well understood. High-speed tools and machines, with their greatly increased consumption of power, emphasize more and more the disadvantage of line shafting. The greater speed and power per machine unit necessitates greater weight and speed in the line shafting and belts, and increases the amount of power lost in transmission—a loss considerably greater than the supposed increased expense of maintaining motors. Evidence of the recognition of this is found in the constantly increasing sale of motor-driven machines of all sorts.

Though there is substantial agreement as to the advantage of the electric drive, there is great diversity in practice in bringing the motor and machine into practical relation. The practice varies all the way between the use of an independent motor driving through a direct belt or indirectly by way of a countershaft, to the mounting of the rotating armature directly upon the main driving shaft. Undoubtedly the latter is the most economical mode of hitching, since it avoids belts, chains, or intermediate gears. It almost necessitates one or more variations in motor speed however—which is not particularly a disadvantage. Usually the method is to attach the motor to the machine at some convenient place and make the connection in one of the ways already mentioned. Aside from the difficulty of avoiding torsional strains where motors are attached by brackets or additions to the frame, it is desirable to have the two adapted to each other as closely as possible so that the highest efficiency of each may be developed. It appears now as if progress pointed in the direction of such an intimate combination of the two that the motor becomes an integral part of the machine, as it would be if the main driving spindle of the latter were also the spindle of the former. Whether such an arrangement is practicable for all the different types of machines may be open to question. Experience has shown that it is in the case of lathes. If there should be practical difficulties in the case of other types, there is no good reason why the type might not be changed or re-designed to meet the new conditions. As in everything else, the traditional strongly influences machine design, and it requires a good deal of courage to break away from convention. Thus the lathe is essentially what it has been from the year one. It is true several forms of machine have been developed out of the lathe, but these also have undergone modifications very slowly.

There is a pretty well-marked tendency in the metal trades toward a greater use of machines making use of the rotary principle and a corresponding disuse of the reciprocating. In other words, the planer, shaper, and slotter are losing ground before the much more efficient milling machine in its several forms. Doubtless it will be a long time, if indeed it ever comes, when the reciprocating tools will be entirely obsolete, for there are likely always to be jobs to which the rotary cutter can not be well adapted. However that may be, it is a proper subject for congratulation that ways are being found to eliminate to a large extent the wasteful reciprocating action and to substitute for it the comparatively efficient rotative movement.

In conclusion, it may be worth while to consider briefly another aspect of the high-speed-steel problem, namely the power consumed in the drive.

Increasing speed, as is well known, rapidly uses up power. The standard machines have been using comparatively little per unit, rarely as much as a single horse power, and except only in machines built for very great power, never as much as two. But the newer machines consume rarely less than three or four horse power, and frequently several times as much. At high speed and with heavy cut, a twenty-inch (swing) lathe has on occasion used up a maximum of thirty horse power, though its average consumption was less than ten, and the minimum a good deal less still. Obviously the amount of power used depends mostly upon the amount of metal removed in a given time, and it does not necessarily follow that because a machine eats up power rapidly it is therefore wasteful. As a matter of fact it is demonstrable that efficiency at high speeds is very much greater, considered on the basis of units of power consumed alone, than at the lower. In other words, on the basis of metal removed and time consumed, the new machines and tools use considerably less power than the standard-speed machines. This paper is already too long to go into details in the matter. It is sufficient at present to point out that under favorable conditions the power required per pound-hour of metal removed varies from 0.03 to 0.07 horse power, which is measurably less than is required under similar conditions with less powerful and speedy machines. A fuller discussion of this subject is intended in a later paper.

EDITORIAL COMMENT

WE have steadily maintained that every engineering problem of the Panama Canal offers a complete solution, the fuller and more satisfactory the farther the study is pushed; and that all the embarrassment which has so far attended the work has sprung from climatic conditions which have been again and again met and practically neutralized in constructive work elsewhere in the tropics, and from administrative and bureaucratic obstructionism which has always appeared in every undertaking executed directly by the Government. Mr. Waldo's article, which is taken directly from the field notes and the personal journals of some of the parties working on the Isthmian surveys, is a remarkable demonstration of all these points, and is given the leading position in this number on account of its importance to an issue of great present National importance. It is further significant in that the Gamboa Dam project, for the first time adequately presented in the "Appendix" to Mr. Waldo's article, is the key to the sea-level plan said to be favored by a majority of the Advisory Board.

The danger in the situation on the Isthmus, of course, is that when the annoyances of red-tape are combined with the physical discomforts of the country, the destructive effect on the economy attained and on the *morale* of the workers rises as the product—not merely as the sum—of the injurious factors. Mr. Waldo's article is presented in the spirit of wholesome criticism, which holds not the slightest doubt of final success in the building of the Panama Canal, but feels that that result will be soonest and most safely reached by arousing a lively sense, on the part of the Administration and the people, of the only present conditions impairing the progress or the prospects of the enterprise.

* * *

AT the time of our going to press, the Advisory Board of engineers, called together to recommend a decision as to the type of canal to be constructed on the Isthmus, have held what is regarded as a final session upon the choice of type, and the result is widely and no doubt correctly announced—eight to five in favor of the sea-level plan. It is further credibly reported that the majority group is made up of the five foreign representatives and Messrs. Burr, Parsons, and Davis, leaving the minority consisting of Messrs. Noble, Randolph, Stearns, Ripley, and Abbot again divided into two parties favoring two variants of the lock type.

It is most unfortunate that if the Board were unable conscientiously to agree upon a verdict substantially unanimous, anything at all should have been made public until the majority were able not only to declare their position, but to support it by so convincing an exhibition of engineering necessity or of reasonable argument that public opinion would be consolidated immediately behind it. So many interests—honest and otherwise—are lining up against the Canal, or preparing to make the Canal the mask for an attack upon the Administration in the coming Congress, that it is deplorable to have popular support perplexed and scattered by a verdict which does not seem to be projected forcibly enough to overcome the resistance opposed to it.

We believe much of the disappointment may be removed by the full statement of the Board's conclusions. Particularly, it may be shown that in the matter of time needed for construction, the sea-level and the lock projects are much more nearly equal than is commonly supposed; this would go far, we believe, to allay the disappointment now expressed. It would be better the country should know more, or that nothing should have been made public. As it is, let us hope an adequate abstract may be ready in time for the President's message—if, indeed, the agreement of the Board to disagree is final.

* * *

It was publicly known in advance of the first convention that various members of this Board were openly recorded in favor of at least three types. Yet the hope of a substantial majority agreement was not unreasonable, whatever may have been the prior differing opinions of certain members of the Board. No commission had heretofore been able so to concentrate its study of the question within perfectly definite and close lines. No preceding commission has had anything like the fund of data presented to this Board—data which in part are said to throw new light on crucial points. A review of the whole case in the light of new evidence might well modify a preceding verdict.

There is one deduction plainly to be drawn from a divided report, if that should be the outcome of the Board's deliberations. It is simply that there are several plans fully feasible, and that one or other of them has appealed most to the individual judgment of the several members as one or other element of the problem (construction, maintenance, operation, cost, or time required) has impressed him as carrying the greatest weight in the solution. We emphasize this because it is the direct contrary of the fallacious deduction which will be shouted forth by the enemies of the Canal. If the Board is not unanimous, it means *not* that the problem is insoluble, but that it has several solutions, each sufficiently meritorious to attract the approval of one or more of the members.

Let us hope one may prove to have such commanding merit that it may justly receive the acceptance of all friends of the undertaking.

* * *

The term "engineer" has been variously defined, from the oft-quoted statement of Tredgold that he is one who "directs the great sources of power in Nature to the use and convenience of man" down to the modern one of Wellington, defining him as the man "who can do for one dollar what any fool can do for two dollars." Both of these, and indeed any definition which can be framed as well, must include the idea that the engineer is an economist. He directs the sources of power in Nature to economical advantage; or, if he does not, he will not save the odd dollar, and hence be no better than any other man, so that the old definition and the new one are not greatly different in principle after all.

Viewed in this light it seems rather curious that engineers, in various countries, should have taken so long a time to appreciate the fact that the business side of engineering work is really included in their professional bailiwick. In this country the desirability of including commercial and economic questions in the work of the engineer has been appreciated earlier than elsewhere, and more than one railroad president has developed from the engineering department into that of administration. The American professional societies have taken an early part in the discussion of questions relating to the administration of industrial work from the business side, and the various scientific methods of remunerating workmen, determination of costs, and solution of the numerous problems of works management, have had their inception or their strongest impetus from the members of the engineering profession. In fact, the so-called business men, familiar with the commercial side of engineering and manufacturing only, have often been eluctant to accept methods devised without regard to the ancient precedents derived from mediæval methods of trade, and it is only with the active entrance of the engineer into the affairs of business administration that modern conditions have been taken into account in a scientific manner.

* * *

On the Continent this question of the discussion of economic subjects by professional bodies of engineers is just beginning. A circular, issued by the Bavarian Section of the Society of German engineers (the largest body of engineers in the world, publishing as Transactions one of the most valuable technical periodicals in Europe), has recently been issued stating that, after due consideration, it has been thought well for the members to contribute to the transactions papers upon related industrial matters. Members are asked for their opinions upon such subjects as the value of economic studies to the engineer, the function of the production engineer, the influence of technology upon general culture, the effects of industrial combinations upon manufacturing industries, scientific methods for the remuneration of labor, the value of engineering statistics; and these and numerous related questions are proposed as suitable subjects for contributions and discussions. Other questions suggested are those including the combination of economic matters with those usually considered as wholly technical. Thus: the influence of the practical applications of the science of thermodynamics upon public prosperity is shown to be important; the development of methods for the use of liquid fuel has a distinct relation to the location and conduct of manufacturing enterprises; the development of automobile vehicles, both for personal and industrial service, is destined to work economic transformations. These and many other subjects of related character are included in a programme mapped out with characteristic German thoroughness, and doubtless destined to cause the publication of many valuable studies.

* * *

In this Magazine it has long been maintained that the economic side of engineering demanded a full share of attention, and reference to the contents of past volumes and numbers, notably the special issue upon Works Management, will show the valuable articles upon the various branches of the subject which have appeared in its pages. Methods of cost keeping, of shop accounting, stores keeping, and engineering administration in all departments, in the field, in the shop, and in the mine, have been discussed; and we believe that we are fully justified in maintaining that the interests of engineers, superintendents, and managers have been more fully and completely set forth in this Magazine than has been attempted elsewhere in any periodical publications. That the largest engineering society in the world is now seriously and formally declaring these subjects to be within the domain of its discussions and transactions, is a gratifying acceptance of a policy always held of controlling importance in the pages of The Engineering Magazine.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE ACCESSIBILITY OF PORTS.

A REVIEW OF THE CONDITIONS GOVERNING THE ACCESSIBILITY OF HARBORS FOR MODERN MERCHANT VESSELS.

Brysson Cunningham—Engineering.

IN response to the continually increasing demand for improved facilities the art of the engineer and of the marine architect has produced vessels of greater and greater speed and cargo carrying capacity. While progress in these directions will doubtless continue, it is generally understood that the limitations surrounding the further development of shipbuilding are not those with which the marine architect can cope directly. The dimensions of modern vessels are being more and more controlled by the limitations of the ports which they have to enter, and this question is becoming one of such importance that a paper by Mr. Brysson Cunningham upon the accessibility of ports, published in a recent issue of *Engineering*, is altogether timely.

Mr. Cunningham reviews rapidly the great progress which has been made in dimensions, powering, and speed of merchant vessels in recent years, and then proceeds to show that further advances must depend largely upon the facilities provided for entering ports, questions belonging mainly to the province of the dock and harbor engineer.

The considerations which exercise the most influence in determining and limiting the accessibility of a port may be grouped under four heads: location; environment; the approach channel; and climatic conditions; and these Mr. Cunningham discusses in order.

The question of location is taken to cover the geographical situation of a port, whether on the sea coast or on the banks of a navigable waterway, and with this may also be considered the second point, viz., that of environment.

So far as mere location is concerned, it is manifest that a position on the seaboard offers distinct advantages over one approached by a river, and this latter situation is being continually placed in a worse plight as the dimensions of vessels increase. Mr Cunningham compares the ports of Marseilles and Havre on one hand with those of Antwerp and Bremen on the other, emphasising the important and expensive works which the Belgian government is being compelled to make, an outlay of 183 million francs being estimated as necessary in order to maintain the accessibility of the port of Antwerp.

Considering the matter of environment, a seaboard position has serious drawbacks, these being mainly those due to exposure to weather. Many ports of the seacoast have been made available only by the construction of costly protective works, such as massive breakwaters, to enclose areas of tranquil anchorage. Natural harbors, with sheltered bays are not unknown, and such examples as Queenstown, Sydney, San Francisco, and Rio de Janeiro are cited, but in many such locations there are attendant difficulties from tides and currents, with their accompanying bars and shallows. River ports have also their difficulties, due to the evils of silting and the growth of vegetation, and in these matters the relative importance of the various drawbacks must be decided for each situation.

"We now come to the third point. The most potent of all the factors governing accessibility is the nature and profile of the entrance or approach channel. Trade will accrue and cling to a particular route, no matter how lacking it may be in natural conveniences, provided it be equipped with a navigable waterway. In fact, whatever other advantages and disadvantages may attend a port, the approach channel is, *de facto,* the censor and measure of its potentialities. It governs the size and class of vessels entering or leaving, and it regulates their speed and the time of their movements. It acts with relentless precision, and its fiat is irrevocable.

"At the same time it has certain redeeming qualities. It is generally capable of treatment and amelioration. Its bed may be improved, widened, deepened, straightened—and so made more serviceable and less obstructive. That this is the case is indeed fortunate, for there are few ports where works for the regulation and improvement of the entrance channel have not been, or have not become, an urgent necessity. In fact, it may be said that some of the most thriving and successful seaports of the present day exist and flourish in spite of obstacles to navigation which would have baffled and daunted any but the most determined and persistent attempts to remove them."

In considering the vital matter of the approach channel, Mr. Cunningham takes the case of a typical modern freighter, intended to trade with a number of ports and having an average load-line draught of 30 feet. Such a draught cannot be considered as excessive, since the average load-line draught of 50 modern steamers touches 31 feet, but it appears that with a 30 foot draught there are but three ports which can be considered as invariably open, these being Marseilles, Genoa, and Tacoma, all on the sea coast and all having a negligible tidal fluctuation. By observing slight tidal restrictions, such a vessel could reach New York, Quebec, San Francisco, and Southampton with fair regularity, and also penetrate the Mersey as far as Liverpool, and the Thames as far as London, but in all other cases the period of access is stringently limited, if not absolutely non-existent.

A load-line draught of 30 feet will doubtless soon be considered very moderate, and the fact that this is appreciated in New York is seen by the active conduct of dredging works to provide a 40 foot depth in Ambrose channel. Such considerations must also have great weight in the plans for ship canals, and doubtless the final plans for the Panama canal will take into account the demands of the merchant cargo vessels of the impending future.

"We come now to the final item on our list. Climatic conditions and natural phenomena may be favourable to the accessibility of a port or they may not. In the latter event they will be found to embrace a variety of impediments to navigation, most of which, at present, at any rate, are largely outside the sphere of human influence. Fog, storm, and frost constitute a formidably maleficent combination, dispensing danger to the navigator, inconvenience to the shipowner, and loss to the merchant. Vessels have arrived within the immediate vicinity of their destination only to be fogbound, or tidebound, or icebound, for periods to be measured in some cases by hours and in some cases by days. Quite recently the Baltic reached the mouth of the Mersey in the early evening, having made the trip of 3,000 miles across the Atlantic at the rate of something like 17 knots, or 450 miles a day. Owing to a dense fog, complicated by low water, the remaining 18 or 20 miles to the Liverpool landing-stage consumed a full 12 hours—a delay as costly as it was vexatious, in that the mail train could not leave for London until noon of the following day. Much valuable time was thereby irrecoverably lost, and the inconvenience caused to business men must have been incalculably serious.

"An incident of this kind, however, assumes an air of trifling importance when compared with the ordinary experience of certain ports in northern latitudes during the winter months. The harbour of Montreal, for instance, is closed by ice, as a rule, from the last week in November till late in the following April. The Baltic ports are almost equally unfortunate; even Boston and New York are not exempt from the inconveniences of frost; and though shores laved by the Gulf Stream are generally free from obstruction, it is little more than ten years ago that the River Mersey was packed with dense masses of ice drift.

"So far as fogs are concerned, nothing apparently can be done at present. The matter is receiving attention at the hands of scientists, and at least one remedy has been suggested; but its range of application is too restricted for it to be capable of anything like universal benefit. Conceivably, in time, some means will be discovered for dispersing wholesale the intangible folds of November's deadly shroud, but the day seems distant as yet.

"Ice, on the other hand, yields to mechanical agency. The late Admiral Makharoff and others have done much to develop and perfect the ice-breaker, especially in Russian waters, where its need is most felt. Yet it is strange that the appliance has not gained greater popularity. There are still a number of ports which submit to the iron grip of winter without an effort to maintain their communication with the open water. Such ought not to be the case at the commencement of the twentieth century and it cannot long be permitted to continue.

"Reviewing the subject as a whole, it will be seen that there is undoubted necessity and ample scope for the progressive treatment of all ports, especially in regard to their entrances and approach channels. Developments take place nowadays at so rapid a rate that any lethargic or fatalistic indifference to the trend of modern ideas and requirements must inevitably be attended by speedy retribution. As is the case with all industrial communities, it is only by keeping abreast of the times that ports can maintain their vitality, or hope to increase their prestige and importance. Vigorous measures, therefore, and a judicious outlay (commensurate, that is, with the resources and prospects of the place) must be held to constitute the essential features of a sound policy in maritime affairs."

THE VENTILATION OF TUNNELS.

PRACTICAL METHODS OF MAINTAINING FRESH-AIR SUPPLIES TO THE RECENT ALPINE TUNNELS UNDER CONSTRUCTION.

Karl Brabbée—Zeitschr. d. Oesterr. Ingenieur u. Architekten Vereines.

IN order to meet the demands of traffic and railway extension there has been a continual advance in that department of engineering devoted to tunnelling, and in the Alpine regions of central Europe especially there is much activity in such undertakings. The older tunnels are passing more trains than ever, and no sooner is a new one completed than plans are made for other and more ambitious borings. In connection with such works the problem of ventilation is a most important one, not only as a part of the operative scheme of the completed work, but also as an essential element in the satisfactory conduct of the boring and clearing of the passage.

It has been estimated that in long tunnel works the power required for satisfactory air supply to the workmen is greater than the total of all other demands for operative machinery, drainage, hauling, etc., so that the relative importance of the subject is apparent. In a paper recently presented before the Austrian Society of Engineers and Architects, and published in several issues of the *Zeitschrift des Oesterreichschen Ingenieur und Architekten Vereines,* Herr Karl Brabbée examines this subject of ventilation of tunnels, and although his investigations relate principally to the modern methods of supplying air to the workmen during construction operations, the general principles developed are of value.

Although the boring of the Simplon tunnel has been already effected there are even now four important Alpine tunnels under construction, namely the Bosruck, Tauern, Karawanken, and Wochein tunnels, and in all of these there are important mechanical plants in operation.

In the light of the practical experience gained in these and other similar undertakings, Herr Brabbée has conducted a number of experiments upon the flow of air under working conditions, and in the absence of any generally accepted system of tunnel ventilation these investigations assume an especial interest.

The earlier method, adopted in most of

the long Alpine tunnels, and still in use in connection with the eastern portion of the Arlberg tunnel, is that of forcing in air through comparatively small pipes under a considerable pressure. On the western side of the same tunnel a departure has been made from this plan to the extent of using somewhat larger pipes, this permitting the desired volume of air to be supplied by ordinary fans. This is a step toward what must be considered the correct principle, that is, the supply of a large volume of air, through conduits of large diameter, and at low pressure. The best example of this principle is seen in the Simplon tunnel, in which the auxiliary tunnel itself constituted the air-supply main, and indeed the late engineer, Brandt, expressed himself as of opinion that this feature constituted one of the most valuable elements in the adoption of the twin tunnel scheme.

In examining the performance of a tunnel ventilating plant there are three subjects to be considered: the motive power, the blowers, and the conduits through which the air is driven.

So far as the motive power is concerned, the use of electric motors is now so general that no other need be considered. While the question of the best form of blades for fan blowers cannot yet be assumed as entirely settled, this was not made a subject of research in the investigations under consideration, a standard type of pressure blower being employed in all the experiments. The real matter for experimental determination was to find the volume and pressure necessary at the beginning of a conduit of given length and diameter which should insure the delivery of the required volume of air at the other end. The problem may also be stated as the determination of the loss in the conduit, being in this respect similar to the allied question in electrical engineering, the loss of current in an electric conductor.

Experiments and formulas for the loss in air conduits have not been lacking heretofore, and Herr Brabbée cites twenty references, dating from 1824 down to the present, and representing the work of many noted engineers, but upon plotting the results of the formulas thus given wide differences appear in the results; two only approaching the mean result obtained by averaging all of them, and the curve being a very irregular one. Under these circumstances it was thought advisable to conduct a series of experiments upon riveted conduits of various diameters in actual service, to determine the loss due to reduction in diameter, and to find out the influence of working and atmospheric conditions upon the efficiency of ventilating pipes.

The apparatus employed is described in detail, consisting of a modified form of Robinson anemometer so arranged as to be inserted in the main through a small opening, and adjustable so as to enable the velocity to be determined either in the middle or near the wall of the pipe; the temperature, pressure, and humidity of the air being simultaneously taken. By arranging a number of test points at different parts of a main the gradual change could be determined in a manner enabling curves to be plotted, and in the original paper numerous curves constructed from the observations are given. We can give here only some of the conclusions deduced, as bearing upon the general question.

The studies involved some 600 separate tests, these being weighed carefully according to the conditions under which they were made and 492 being taken as fairly representing the actual facts as closely as could be ascertained. They included measurements made upon pipes of 300, 500, 700, and 800 millimetres in diameter, or say ranging from 12 to 30 inches, in lengths of 300 to 900 metres, or say 1,000 to 3,000 feet, so that the scope of the investigation may be considered as ample.

The first result of the tests was to establish the fact that the coefficient of friction of the air in the mains was practically constant for pipes greater than 500 millimetres, or say 20 inches, in diameter, being equal to 0.0175 for velocities from 4 to 17 metres per second; but rapidly rose for smaller diameters. The loss in pressure was found to depend upon a certain coefficient similar to that found in connection with the flow of water in pipes, and upon the coefficient of friction, which, as above noted, is constant for constant conditions of size, state of air, and kind of pipe. The formula deduced by Herr Brabbée appears to be a pure parabolic function of the velocity, provided the specific gravity of the air and the length of the main remain constant. Assuming a specific gravity of 1.2 kilogrammes per cubic metre, and a main of 200 metres in length, Herr Brabbée plots the results in curves for diameters from 300 to 800 millimetres, these showing the action very clearly.

In actual practice it is recommended to use a large pipe, that is, above 500 millimetres in diameter, for the principal part of the main, reducing this to about 300 millimetres as the working headings are approached, in order to diminish the liability to loss from deformation due to explosions in blasting, etc.

The diagrams accompanying the investigations are of much interest, and the whole forms a valuable contribution to an important engineering question.

ASPHALT PAVING CONSTRUCTION.

A DISCUSSION OF THE CONTROLLING FACTORS IN THE CONSTRUCTION, MAINTENANCE, AND COST OF ASPHALT PAVEMENTS.

Andrew Rosewater—League of American Municipalities.

IT has been said that the beginning of asphalt pavements was made in Paris by Napoleon III., because the stone blocks previously used provided too convenient a material for the construction of barricades in times of revolution. Be that as it may, there is no doubt that this very desirable form of pavement has come into use in countries where the barricade question did not enter, and in the course of the half-century since the *coup d'état* the use of asphalt has become very general.

In a paper presented before the League of American Municipalities by Mr. Andrew Rosewater, the subject of asphalt paving construction is discussed at length, and in view of the fact that there are now in the United States some twenty-five hundred miles of streets of such paving, covering about forty-four million square yards, the importance of the question is manifest.

Mr. Rosewater discusses at some length the history of the subject in the United States, with especial reference to the matter of monopolies and competition, and shows that at the present time there are a number of sources of entirely reliable material, and that the proper way to treat this side of the question is for the municipal engineer to prepare careful specifications for himself, and place the work in open competition, subject to proper engineering supervision.

"In asphalt, as in all other pavements, the first essential to good, durable construction is a proper base. A good earth road requires, first of all, proper drainage, both for surface and sub-surface. The solution of this feature is a simple engineering proposition. The next essential is consolidation—the more compact, the less will the surface yield to vehicle traffic, and the greater is its durability. The fact that earth yields readily to the softening and dissolving influence of water demands a very high crown upon an earth road that it may shed water as fast as possible to escape its softening agency. The fact that it partly dissolves when wet makes a soil yield more readily when porous because these voids will quickly absorb, or fill with the dissolving agent; hence the more compacted and less porous, the less it will be exposed to moistening influences.

"Again, if the earth roadbed is subjected to water from beneath the surface, it will not only be undergoing constant change in the summer period, but when winter comes the water, when freezing, will expand and heave up the surface. With these fundamental principles outlined, we next come to the pavement proper.

"Divested of all verbiage, a pavement is a veneering or wearing road surface. It is placed there to protect the base and give it durability. The early attempts at pavements were of the old Roman road order, consisting of layers of large blocks of stone in mortar, which distributed the load over a much wider area than that directly exposed to the tires of the wheels. These roads have numerous variations, such as slabs of granite laid in parallel rows for the wheels to run on; tram railways, with iron or steel surfaces distributing their loads through the medium of ties or planks to the earth surface; the macadam roads developed about 100 years ago, with depths of broken stone, varying with the traffic, and depending for their efficiency upon compacting the aggregates, first on the traffic, which took years, and later upon great road-rolling machinery, which crushed and forced the various aggregates to a wedged and compact mass, developing a smooth surface."

Mr. Rosewater considers the factors of a good asphalt pavement to be a good subdrained compacted base, upon which rests an intermediate monolithic material, with a covering of asphalt having a wearing capacity capable of meeting all traffic conditions and resisting the destructive action of temperature changes and climatic influences. The intermediate material he considers best made of Portland cement concrete, of sufficient strength and thickness to transmit the load uniformly to the earth beneath.

Taking up the question of the asphalt covering as the matter under consideration, there are certain requirements which it should meet to be considered satisfactory. Thus: the asphalt covering must be compact and hard enough at all times to meet traffic requirements. It must not be readily affected by water, it must be durable, retain its smooth form, and not become slippery. These requirements mean that the component elements of the covering must be such as to become a solid, voidless mass that can resist the compression of traffic, and expansion and contraction of temperature extremes.

"Experience has shown that asphalts from Trinidad, Venezuela, California and numerous other sections of the country, 60 per cent. of whose bitumens are soluble in boiling naphtha, possess sufficient adhesive cementing qualities to make a proper paving cement. Experience has further developed that the actual and necessary quantity of bitumen thus soluble to make a proper paving mixture shall range between the extremes of 10 and 13 per cent. by weight. The exact proportion will vary between these figures, dependent upon the nature of the sand grains and voids in the sand. The specifications should, to insure good results, provide that not less than 10 per cent. of bitumen shall be required in the mixture. This does not mean 10 per cent. of asphalt, for what is known as refined asphalt varies in the degree of refinement. Bermudez, Venezuela or California asphalts are, when refined or manufactured, free from sand or other mineral mixtures, and, therefore, contain from 95 to 99 per cent. pure bitumen. The Trinidad asphalt, as refined, contains fine, impalpable mineral powder to the extent of 36 per cent. In the latter case it requires more asphalt to produce the 10 per cent. of bitumen, but, on the other hand, the amount of filler of stone dust or Portland cement required with this asphalt is proportionately less than with the others."

Mr. Rosewater shows that the common method of comparing asphalts according to the amount of bitumen they contain is erroneous and objectionable, since 10 per cent. of extracted bitumen must be added in any case. To exclude asphalts containing less than 90 per cent. bitumen is to exclude some of the best materials in the market, while admitting others of inferior quality. Municipal interests are best subserved by providing specifications calling for open competition as to asphalts, and asphalts of requisite quality can best be obtained by providing for the minimum of bitumen in their mixtures subject to the boiling naphtha test, which determines the malthene or petrolene components which constitute the cementing quality of asphaltic bitumen.

Taking up the question of the sand, which forms 90 per cent. of the asphalt covering, Mr. Rosewater calls attention to the varying grades of natural sand, and states that the problem of determining the best grade of sand for pavement purposes is still only partially solved. The best results appear to be obtained by substituting finely ground Portland cement in place of stone dust, and by specifying about 12 per cent. of cement excellent results will be secured at a cost of only a few cents per yard over sand.

"The history of municipal growth has shown it impossible to avoid constant cutting up and otherwise disturbing the paved surfaces of urban streets. Water-works construction, sewer construction, gas construction, and telegraph, electric light, telephone and other conduits of every kind are brought into demand with each new discovery and each new construction, and the problem of finding a pavement that is permanent is as unsolvable as the squaring of the circle.

"The only feature of permanency existing in public works is that of permanency of repairs. In connection with asphalts, as well as other pavements, the economic lines are along those of prompt attention to the repairs before the cuts are enlarged by traffic. Twenty years of close observation of municipal conditions leads me to the conclusion that every city should have a plant and an organized corps of skilled men to attend to the maintenance and repair of its paved streets. Once equipped with the best of modern appliances, streets can be kept in a condition of continuous repairs at the minimum cost. To do this the construction and engineering departments must be divorced from partisan politics and placed under a permanent system of civil service."

So far as cost goes, Mr. Rosewater gives a division of the different departments of a pavement, showing that the concrete base represents 38 per cent. of the total cost, and the asphalt covering about 29 per cent., the balance being divided among the costs for excavation, superintendence binder, and miscellaneous items.

SINGLE PHASE ELECTRIC TRACTION.

SALIENT FEATURES OF SINGLE-PHASE ELECTRIC TRACTION AS APPLIED TO STREET RAILWAY SERVICE.

Charles F. Scott—American Street Railway Association.

THERE has been much talk of late about the merits and demerits of the single-phase electric motor as applied to traction purposes, and while various practical applications have already been made there is room for a better understanding of the system by those interested in traction matters. For this reason the paper presented by Mr. Charles F. Scott before the American Street Railway Association, upon the single-phase railway system is of especial value at the present time, and demands attention and review. Naturally the comparisons which are made are between the continuous-current motor, now so generally in use for electric traction service, and any other which it is proposed to substitute for it.

"The radical difference between railway systems using direct-current motors and those using single-phase motors is not so much in the car or the power-house as it is in the circuits connecting them. In the first place the high voltage used on the trolley wire does away with expensive feeders and it also enables the current to be carried to a greater distance from the power-house or from the substation. Second, the substation employed in the single-phase system requires simply a lowering transformer. The substation for supplying a direct-current railway requires the rotary converter and a set of lowering transformers. Third, the number of substations for a single-phase road is less than is required for direct current and these do not require the attendance which is necessary for the operation of rotary converters. It is these characteristics that peculiarly adapt the single-phase system to interurban and long-distance railways."

Mr. Scott emphasises the fact that a satisfactory motor is not all that must be realized to make a single-phase traction a success, but that the system must be completely worked out as a whole. This includes the design and construction of control apparatus adapted to the new conditions, and available for small cars and for heavy multiple-unit equipments. Transformers, line switches, and other auxiliaries must be designed, and combined with suitable overhead construction adapted to the current and voltage conditions, and it is a whole system, and not the mere design of a motor, which must be considered in referring to the question of single-phase traction either for street railways or for interurban service.

"In how far have the advantages claimed for the single-phase system been realized? Among the important features are the following:

"A high-voltage trolley construction has been developed and has proved to be simple, strong and thoroughly practicable.

Thirty-three hundred volts has been used and has proved to be safe and reliable.

"A sliding contact device which does not require reversing when the direction of the car is changed is found more satisfactory, especially for high-speed operation, than the trolley wheel. Its wearing surface lasts longer than trolley wheels operating lighter cars on direct current.

"Transformer substations supply current satisfactorily without feeders and without station attendants.

"The car equipments show simplicity and effectiveness in the control apparatus. Less than half the controller notches required for direct current give equally smooth and as rapid acceleration with alternating current. Platform controllers are simpler as no magnetic blow-out is required. The unit control system is readily adapted for the operation of single-phase motors and is in some points simpler than the control of direct-current motors.

"The operation interchangeably by alternating current and by direct current is a feature of an important road which operates large equipments on direct current in the city and on alternating current across country.

"Motors of four or five sizes have been built and show excellent commutating features. The commutators take a good polish. The motor windings are such that there is a practically balanced magnetic pull, even if the armature be slightly out of centre. Although the armature speed is higher than in corresponding direct-current motors, the advance criticism has proved ill-founded as there have been no bearing troubles. The oil lubrication has proved highly satisfactory.

"The foregoing features, which are the important elements upon which the claims of the single-phase system are based, have been shown by actual operation to be entirely feasible and practicable, and such as to inspire confidence.

"Difficulties have been met which have been annoying and vexatious. The difficulties, however, have usually been due to some error in the general features or to some specific point of weakness in the insulation or construction of some part of the apparatus. In other words, the troubles have not been fundamental and inherent in the single-phase system, but have been incidental and capable of ready remedy."

There are some misconceptions about the advantages of the present continuous-current motors in use which Mr. Scott clears away, and a right understanding of the points is of material assistance in examining the advantages of the single-phase system. Thus, it is generally supposed that the continuous-current motor is a variable speed machine, but in fact it is, fundamentally, a one speed motor, the speed depending upon the voltage, and only variable from this normal speed by the use of resistances, a wasteful and temporary method, or by the use of more than one motor, permitting operation in series or in parallel. The limitations of the continuous current motor in this respect are well seen by examination of the various efforts which have been made to secure a satisfactory speed control for motors used in operating machine tools in workshops.

It is well understood that satisfactory speed control involves effective voltage control, and this desideratum, not efficiently attainable with the direct current, is easily secured with the alternating current.

"The simplest method of variable voltage is by means of taps from the transformer winding. The low voltage required for starting is obtained from a low tap and the successively higher voltages for increasing speeds are secured from successively higher taps from the winding. As there is no rheostat the motor may run efficiently from any tap, thereby giving the motorman a control over his car movement which is not possible with direct current."

Mr. Scott refers to the successful behaviour of the single-phase system in practical operation, citing especially the equipment of the Indianapolis and Cincinnati Traction Company, which has been operating more than thirty-seven miles of road for nearly a year.

Other shorter lines are also in operation with success, and plants now under construction include 150 miles of railway running south from Spokane, Washington, and also single-phase locomotives for hauling the passenger trains of the New York, New Haven & Hartford Railroad Company into New York City.

CORROSION OF STEAM BOILERS.

THE INFLUENCE OF CORROSION IN THE PRODUCTION OF FURROWS AND GROOVES IN BOILER PLATES.

Ch. Frémont and F. Osmond—Revue de Métallurgie.

AMONG the causes of the deterioration of steam-boiler plates one of the most insidious is the corrosive action to which may be attributed the grooving and furrowing so frequently observed in cases of failure. The manner in which these injurious and weakening grooves are formed has been a matter for discussion for a long time, and no very satisfactory theory has been advanced to account for the peculiar way in which corrosion appears to produce furrows as deep and straight as if they had been produced by a cutting tool.

In a recent issue of the *Revue de Métallurgie* this question is examined by MM. Fremont and Osmond, and the extent to which their views agree with the results experienced in practice renders their discussion an important contribution toward the solution of this obscure problem.

When a sheet of iron or steel is exposed to the action of air and moisture it becomes oxidised more or less rapidly. This oxidation is effected principally by the carbonic acid which is present, since the free oxygen which may be present has only the power to raise to a higher degree of oxidation any protoxide which may be already in contact with the metal. Since the various conditions of temperature, pressure, chemical composition, etc., remain constant in the case of a given boiler, any irregularity of the rate of corrosion must be sought in the original variations in the structure, or in the unequal conditions dependent upon construction or service of the various parts. In general the irregularities in corrosion of boiler plates may be divided into two classes, pitting and grooving. The isolated regions of corrosion known as pittings consist of separate cavities, apparently due to independent causes, although occasionally uniting or merging into one another as their area is extended. Grooving, on the contrary, consists of distinct and continuous furrows, resembling the scoring effects of a cutting tool, this action being generally observed along seams or other parts of the boiler which are subjected to flexure in consequence of the stresses caused by service.

There is no doubt that the origin of these forms of corrosion may be partly attributed to the condition of the metal due to the treatment received in the course of manufacture. There are also various shocks and effects of fatigue under pressure which must be taken into consideration, and the manner of corrosion is undoubtedly influenced by all of these considerations.

Local pitting is probably caused, in most instances, by local variations in the constitution of the material, the presence of sulphur, manganese, slag, etc., forming points of attack which yield more readily to the action of the acid than do the homogeneous portions of the metal. Probably the lack of homogeneity also permits the formation of local electrical currents, facilitating an electrolytic action of more or less definite character.

The peculiar action of grooving, however, demands another explanation, and it is to this subject that the paper of MM. Frémont and Osmond is devoted. The noticeable feature about grooving in steam boilers is its localisation, so to speak. The furrows are generally found running parallel and close to the riveted seams, and as long ago as 1863, in the report of the Manchester and Midland Boiler Association it was described in this significant manner: "Furrowing along a seam of rivets, or rather under the line of an overlap, is found to be the usual malady."

This localisation of the furrowing action leads to the idea that it must be connected in some manner with the structural details of the boiler, in connection with the conditions of its operation. In general, observations upon furrowing in boilers show that this effect appears in nearly every case at places where there is a change in the thickness or strength of the material, or where, from the form of the parts, there is a localisation of surface stress. Following out this lead, MM. Frémont and Osmond have shown a very reasonable explanation for the manner in which grooved corrosion is produced.

Under ordinary conditions, with a uniform and homogeneous material the oxidation of a metal plate should proceed uniformly over the entire surface, covering it with a layer of oxide of equal and continually increasing thickness. In a steam boiler, however, there are conditions which prevent this uniform action. A boiler is subjected to varying pressures and stresses, and these cause continually changing flexures and deformations of the various parts. A flue or shell, riveted up of plates, is not truly cylindrical, however carefully it is made, and the notable departures from true circular section appear at the riveted seams, where the lap of the plates and the thickness of the metal occur. Even with butt joints and cover plates there is a marked change in thickness of metal at the seams, and the same is true, although to a smaller degree, with welded seams. As a consequence of these structural requirements the flexure stresses in the plates are greatest at or near the seams, and although this localisation of stress is not extreme, it is frequently repeated.

When, therefore, the interior of a boiler becomes covered with a thin layer of oxide, this layer is not permitted to remain as a continuous coating, but is broken, or cracked at the points which are subjected to the greatest stresses and flexure, the oxide itself being very brittle and almost wholly incapable of resisting deformation. These cracks and fissures in the general layer of oxide uncover surfaces of clean metal, permitting renewed and vigorous action of the corrosive elements present, and a slightly deeper effect is produced along the line of the break in the oxide. Like many other actions, this tends to extend itself, since the first localisation of the corrosion renders the metal slightly weaker along the line of its direction, rendering the next flexure still more sharply defined in the same place, and causing a fresh surface of metal for corrosion to be exposed, so that the furrowing action continues indefinitely.

This theory is found to be fully sustained when the portions of the sheets under consideration are subjected to microscopic examination. In the paper of MM. Frémont and Osmond there are given reproductions of a number of microphotographs, all tending to confirm the fact that any action which produces unequal surface stress is liable to cause increased oxidation, in the form of grooving and furrowing.

MM. Frémont and Osmond refer with commendation to the paper of Messrs. Houghton and Rogers, recently presented before the Iron and Steel Institute, but show that their own work was done before this latter communication was made public, both series of investigations, however, agreeing in the main as to the causes of the action under consideration.

TRAINING FOR MINING ENGINEERS.

A DISCUSSION OF THE NECESSARY COMBINATION OF SCIENCE AND PRACTICE IN THE EDUCATION OF MINING ENGINEERS.

Dr. J. B. Porter—British Association for the Advancement of Science.

DURING the recent South African meeting of the British Association for the Advancement of Science, gatherings were held at the more important of the cities visited, papers being read and addresses delivered in various places. Among these addresses one of the most noteworthy was that by Dr. J. Bonsall Porter, of McGill University, Montreal, upon the question of the education of mining engineers. This subject is one especially appropriate for a South African audience, amid surroundings largely related to mining, and in a country where engineering problems of great variety and difficulty have been encountered and solved by the application of modern scientific methods.

After reviewing the development of mining methods, from the crude beginnings of early periods, down to the introduction of modern scientific appliances, Dr. Porter showed that at the present time mining and metallurgical processes are conducted in a manner similar to those of any other branch of engineering. Haphazard prospecting is replaced by scientifically conducted geological surveys, employing accurate appliances for borings, and following rational industrial and manufacturing methods.

All this involves, or even demands the methodical scientific education of the engineers by whom such work can be done, and it is of this matter of the training of mining engineers that Dr. Porter had chiefly to speak. In so doing he deprecated the idea of early and extreme differentiation and specialization so often undertaken, believing rather that a broad and sound foundation should be laid for the support of future work.

"The same fundamental sciences underlie all branches; the same training in physics, mathematics and mechanics is essential to a true understanding of each profession, and the man who learns these and other fundamental subjects thoroughly, even at the expense of technical training, is far more likely to succeed ultimately in any special work than the man who has received elaborate training in one line, but whose first principles are weak. Furthermore, not one student in a dozen knows, when he comes up to the university, which branch of engineering he really prefers; still less does he know which one he will ultimately practise. Young engineers are no less subject to chance and circumstances than other men; and for this reason, even if there were no better one, we should strive first to make our men engineers, and then only to give them special training.

"The fact that no man can tell in advance what his life's work will be is sometimes used as an argument in favour of a general engineering course, with a smattering of everything. It is true that an intelligent boy who keeps his eyes open will learn not a little of many practical things in connection with his theoretical studies, and an effective method of teaching is to point theory with practical illustration whenever this can be done without losing sight of the main issue. It is, however, a most serious mistake to make a course general rather than thorough, and even a speciality really well taught is better than broad but shallow instruction."

A mining engineer has generally to do his work under difficult conditions, being often alone and obliged to meet many and varied problems and solve them with his own unaided resources. General engineering work and surveying are his daily tasks; simple problems in electrical and mechanical engineering must be disposed of without the assistance of specialists, while a good knowledge of geology, with some mineralogy and chemistry, is absolutely essential. Such conditions require that a certain degree of practical and technical training should form a portion of the education of the mining engineer, and Dr. Porter's views upon this much-discussed feature are of especial value.

"An engineering student, whatever his branch, should undoubtedly do some shop work on the ordinary materials of construction at a very early period in his course. He will not be able to spare time enough to become a skilled workman, or even a half-skilled apprentice, and he must be made to fully understand this; but he can and should work long enough to know something of the use of tools, and to understand the qualities of the materials of construction which he is about to study theoretically. This elementary shop work is often attempted in workshops connected with the technical schools themselves, and frequently the work can be done in the afternoons while regular studies are going on. This method is economical of time, and there are many advantages in having the teaching and shop work under the same direction; but in many cases it is better for the boys to get their experience in ordinary shops, where they should be required to work full time under ordinary shop discipline. In no other way can they be made to realise what work really is; intimate acquaintance with workmen is also very useful.

"This shop work can usually be arranged for the long vacation, which should be long enough to give time for it, and for a reasonable holiday. Two periods of two or three months each should suffice for an ordinary boy, especially as practical technical training is also required at a later period in his course.

"This technical work is even more important, in my opinion, than the shop experience. It should, if possible, follow the general science teaching, and precede the specialisation. Whenever practicable the student should obtain *bonâ-fide* employment in some works in his chosen speciality, but the exact nature of the work is of no very great moment, so long as it is good engineering work, done by good workmen intelligently directed. The important thing is, again, to get the student in touch with real work and real wage-earners, and to give him an idea of scale. The elementary shop-work may be done, if necessary, at convenient times in a school workshop; but this technical work must be real in every respect. The student should, for the time being, become a plain workman on wages, responsible to his foreman for certain duties, and liable to penalty or discharge for cause.

"The time to be given to the work must depend on circumstances. Three months, under the right sort of foreman, in a small but interesting mine or works will teach as much as a year of ill-directed drudgery. Furthermore, students differ greatly in the readiness with which they take to practical work. Many men are the better students for having had many years of hard apprenticeship; but very frequently the man who has spent a year or more in practice finds it difficult to return to his classes. He is earning money at work, and can often ill-afford to give it up, and again become dependent on his people. Study also often proves irksome, and sometimes very difficult, after a man has been actively employed in work. As a result, many men fail to return to their final studies, and thus lose what should be the most useful part of their education.

"If a definite time for practical experience must be set in advance, it may be said that two periods of about four months each in different works, or one period of a year, would be about right; but in this, as in all other matters of technical education, it is far better to make the regulations somewhat elastic in respect of field work and advanced study. Much time can be saved the students, and their work made more effective, if each case is separately considered by the responsible head of their department."

After a student has passed through this period of practical experience his final studies should be taken up, the teaching becoming more specialized and quite technical, care being taken at the same time to keep fundamental principles in sight. The appliances of the technical laboratory should be freely used, but both in the laboratory and in the lecture room care should be taken to teach principles rather than processes. One or two heavy investigations are far better than many short experiments, and the instructor in charge can often do his men far more good by showing interest and yet letting them work out their own salvation wherever possible, than by being too ready to set up apparatus and smooth over difficulties.

Dr. Porter calls attention to the importance and value of a knowledge of methods of determining costs and making estimates, and while reliability in these departments can come only by experience, it is gratifying to see that he emphasizes the fact that the mining engineer, like every other kind of an engineer, must be a business man also, if he is to achieve success under modern conditions of work.

ACCOUNTING METHODS FOR MINING SUPPLIES.

THE WAREHOUSING AND ACCOUNTING SYSTEM DEVISED FOR THE LAKE REGION IRON MINES OF THE UNITED STATES STEEL CORPORATION.

W. M. Jeffery—Lake Superior Mining Institute.

At various times we have published and reviewed in these pages articles upon methods of cost keeping and stores accounting for machine works, contractors, and manufacturers, and the subject is one of wide-spread interest and importance. Stores keeping has been brought to a science in many workshops, and from a paper presented before the Lake Superior Mining Institute by Mr. W. M. Jeffery it is evident that excellent progress has also been made in connection with mining work. The organization of the United States Steel Corporation brought together a number of establishments which had previously been operated independently, and it is in connection with the iron ore mines of this company that the plans described by Mr. Jeffery have been perfected.

"When we take into consideration the fact that our mining supplies constitute approximately 30 per cent. of the cost of producing our ores it is not to be wondered at that operators are deeply interested in the methods of accounting for such a large percentage of the producing cost. The first duty of an individual, a copartnership or a corporation with a valuable asset to be intrusted to the care of an employee is to select a person who has the ability and the honesty to take good care of and account for such asset. A large amount of capital is required to be invested continually in material necessary for the operation of our mines and sufficient material must be on hand at all times to assure continuous operation. It would be false economy, surely, to allow the stock of material in our warehouses to reach a point where operations would have to be delayed awaiting the receipt of material. On the other hand, an excess stock needlessly tying up capital must be guarded against and the oldest stock should be worked off whenever possible to prevent its becoming obsolete.

"To accomplish the result of having our material account well guarded and to keep our investment in material at the lowest point consistent with economical operation some of the mining companies have adopted the plan of general warehouses—that is, where a mining company owns several mines in one locality, although the mines may be separated by considerable distances, they have a warehouse as centrally located as possible, where the entire stock of supplies for all mines is carried. This plan, in the first place, necessitates but one warehouseman with special ability for this work and saves the cost of having a man of this class at each mine. Clerical work of the warehouse can be done by cheaper labor under the direction of this one man. In the second place, this arrangement permits of carrying a smaller stock of supplies than would otherwise be possible. It is unlikely that a similar part of any class of machines will break at all mines at the same time. and one or two spare pieces carried in stock will guard the interests of all mines in the vicinity, whereas separate warehouses, one at each mine under its own warehouseman, would in all probability each have a part for a similar machine, as the warehousemen would possibly not be in close touch with each other. The extent our stock of mining supplies is reduced by the plan of central warehouses can only be realized by one thoroughly familiar with supply work. It may be said in passing that a great saving in the quantity of supplies necessary to be carried can be accomplished by using as far as possible uniform machinery at the various mines. This is especially true in the case of power drills, steam shovels and pumps."

Mr. Jeffery goes into the system of accounting somewhat in detail, with reproductions of the warehouse records and supply cards.

The invoices for purchases are received in duplicate, and checked by the party responsible for the order, and then forwarded to the point to which the supplies are consigned. The duplicate is sent to the warehouse to be returned when the goods have been received, while the original is held by the clerk at the mine office until the receipt of the goods at the warehouse has been certified by the reappearance of the duplicate, so that the coming together again of the two invoices forms a complete check upon the transaction.

The warehouse records consist of a freight receipt book, a box of supply cards, and a supply of debit and credit slips. The freight record book keeps an account of all material received. The supply cards are ruled in ledger form and enable an account to be kept of each grade or class of supplies, one side showing the quantities received, with information as to consignor, quantity, price, and amount, while the other side shows date, account for which supplies were used, quantity, price, and amount. The cost of operating the warehouse is not included in the cost of the mining supplies, but is treated as a separate cost account, just as is office expense.

The charging of the supplies to operating accounts is based upon the price of the oldest supplies on hand until all items of that lot have been consumed, and then using the price of the next lot until they are consumed. The disbursement of the supplies are recorded by means of the debit and credit slips. No supplies are issued from the warehouse without an order from the superintendent of the properties or some one duly authorized by him; the orders stating the items of the supplies required, and bearing the proper signature. The warehouseman enters on the debit slip the amount to be charged to each of the operating, construction, or improvement accounts, while corresponding entries are made upon credit slips for each class of supplies delivered. The total of the credit slips for a given period must equal the total of the debit slips for the same period, showing that the articles and values charged to the cost accounts agree with the articles and values credited to the supply accounts, while the balancing of the supply cards shows the quantity and value of every kind of supplies on hand. A monthly balance sheet enables a general view of the whole business to be obtained.

"The benefits to be derived from a system of this kind are many. The first that we would mention is the fact that we are enabled to get a correct supply cost on our cost sheets by being able at all times to know absolutely the cost of each article of supplies, because the inventory is so well guarded from leaks of different kinds it is not necessary to add to our supplies consumed a percentage of profits to make up for any possible loss in the handling of supplies. If a cost sheet is to be of any use to an operator it must be accurate; otherwise it is misleading rather than beneficial. Anything therefore tending to improve the cost sheet is of great benefit to the operator who is responsible for the cost of producing ore.

"Next in importance is the benefit of having the supply records in a condition where the warehouseman knows absolutely what he has in stock and can be governed accordingly in making requisitions on the purchasing department for additional supplies, thus keeping down the investment in mining supplies to the lowest point consistent with good operating.

"Another important advantage in a system of this kind is the readiness with which an inventory may be arrived at at the end of the year, or for that matter at any time during the year. All are familiar with the task of taking a complete inventory at the end of each year, when the weather conditions are very unfavorable, when no one knows just how the supplies are going to come out, when the closing work of the year makes it hardest to spare the necessary time and when the time for taking the inventory is necessarily limited. If this system is carried out as it should be and the cards checked continually with the actual material on hand there should be no hesitancy about taking the card inventory at the end of the year as being actual.

THE DISTRIBUTION OF POWER.

PROGRESS IN THE GENERATION AND LONG-DISTANCE TRANSMISSION OF MECHANICAL ENERGY BY ELECTRICITY.

W. E. Ayrton—British Association for the Advancement of Science.

AMONG the valuable and interesting papers presented before the British Association for the Advancement of Science during the recent meetings in South Africa the address of Professor Ayrton upon the distribution of power demands attention, not only because of the importance of the question itself, but also for the brilliant manner of its presentation.

Referring to a lecture given by himself in 1879, Professor Ayrton called attention to the fact that Johannesburg, where he was then speaking, had been founded only five years after, and that the development of practical applied electricity had grown up almost within the same period as had seen the development of the city in which he was speaking. With this growth had come the appreciation of the fact that high voltages enabled electrical energy to be transmitted over long distances with but a moderate loss, and in 1891 it was shown that more than ten times 2,000 volts could be successfully used to transmit more than 100 horse power over more than 100 miles with more than 75 per cent. efficiency in the case of the Frankfort-Lauffen transmission. The explanation of the advantages of high voltages for long-distance transmissions was discussed by Professor Ayrton, showing that the use of higher and higher pressures has enabled larger and larger amounts of power to be transmitted over longer and longer distances, with greater and greater efficiency, that is, with less and less waste. This important fact is examined by Professor Ayrton at length.

"The electric current, as you know, is used for lighting buildings, driving machinery, propelling cars and trains. But throw away the notion, if any of you still have it, that electricity is a kind of gas, or oil, or fuel that is used up in these operations. The common expressions, buying electricity, consuming electric current, are most misleading, for just as much electricity flows away per minute—through the return conductor—from your electrically lighted house as flows to it through the coming conductor. If, therefore, it were electricity that you had undertaken to pay for, you must have made a very bad bargain, because you do not retain the smallest portion of what you would have agreed to purchase.

"The electric current is like a butcher's cart carrying round meat—you no more consume current than you consume cart. It is not the vehicle, but what it leaves behind that the consumers buy—meat in the case of the butcher's cart, and energy in the case of the electric current.

"Exactly the same considerations apply to the distribution of power, with air at 70 lb. pressure per square inch, to the thousands of rock drills on the Rand, to the distribution of power with water at 425 lb. pressure per square inch down the shaft of the Rietfontein Mine, and at 750 lb. pressure in the workshops of the Central South African Railways at Pretoria.

"The energy conveyed with air, with electricity, or with water is made up of three factors—(1) the current, (2) the time during which it flows, and (3) the pressure under which it flows; while power depends on the current and the pressure only."

Naturally the value of the ability of long-distance-transmission of power depends upon the possession of power to transmit, and this includes a clear understanding of the meaning of the term power. In engineering, power has one very definite meaning—the rate of doing work, that is, it includes the time element, so that a high pressure or head, as it is termed, must be maintained over a definite period of time. One of the great advantages of electricity is that it may be employed to transmit the power generated by natural sources of energy, such as waterfalls, to points where they may be used to commercial advantage. The advantage appearing in the use of high electrical voltages is indicated by Professor Ayrton by showing the analogous condition which exists in the case of water power.

"When water has but a few feet of head, the quantity flowing over a water wheel must be large if much work has to be done. But since the water comes to a low pressure wheel along an open stream and flows away again along an open stream, no expense has to be incurred in laying down large pipes. If, however, it were necessary to distribute much power over considerable distances through a pipe conveying such low-pressure water, the pipe would not only have to be long, but of large cross-section, and therefore very bulky and costly."

In the case of water power, therefore, the question of volume and head both have to be considered, and in the case of electrical transmission the corresponding questions of voltage and current are the important features.

Discussing the main subject of the development of power, prior to its transmission, Professor Ayrton examines the possible sources of power in South Africa, including the much-discussed subject of the utilization of the power of the Victoria Falls of the Zambezi river.

"Probably, like myself, you have heard vague comparisons made between the power of the Victoria and the Niagara Falls. Now, what is the true comparison?

"The flow at Niagara varies at different times of the year from about 62 to 104 million gallons per minute. At the Victoria Falls the flow can be as little as one-twelfth of the smaller number—for it is so now; and some authorities, well acquainted with the spot, say that at the end of another three months the flow will only be half of even that. The mean available drop at Niagara is about 160 feet; at the Victoria Falls about 380 feet. Hence, while the *minimum* Niagara flow represents about 3 million horse power, the *present* Victoria flow represents about 580,000 horse power, or only about one-fifth of the Niagara flow. Further, if those who predict the flow of the Zambezi sinking to something like 2½ million gallons per minute in November are true prophets, the Victoria Falls will then only give out about 300,000 horse power, or, say, one-tenth of the *minimum* that Niagara produces.

"In all that precedes, I have taken the full power of the direct drop in each case; that is, I have assumed in each case the intake to be close to the main drop, and I have deducted nothing for inefficiency of machinery."

So far as the actual transmission of large quantities of energy over long distances is concerned, numerous examples show us the extent to which this has already been done. Thus, in Italy 3,300 horse power has been sent over 22 miles at 40,000 volts. In the United States distances from 100 to 200 miles are regularly spanned by wires conveying electric currents at pressures of 50,000 to 60,000 volts, transmitting 5,000 to 15,000 horse power, and in one case more than 4,000 horse power is sent over 110 miles by the use of a pressure of 67,500 volts.

All of the installations employ alternating currents, using transformers to raise the voltage at the transmission end of the line and to reduce it again at the receiving end, but Professor Ayrton is not altogether sure that the alternating current is the best for this purpose. That there are advantages in the alternating current dynamo for the generation of the electrical energy must be conceded, but with improvements in continuous-current dynamos there is no reason why high voltages may not be employed for currents of either kind, and from the point of view of economic transmission 60,000 volts alternating means exactly the same as 60,000 volts direct. Indeed, from the point of view of the maintenance of insulation, the advantages are in favor of the continuous current. This is especially the case if we consider that with the alternating current there is a possibility that resonance effects may produce pressures far above the normal working voltages.

"Much damage has been done to electric cables, used for the distribution of power, by these unexpected high pressures produced by resonance in alternate current circuits. A cable may have been tested at twice or thrice the working pressure and passed as satisfactory. But if there is a liability of a pressure being applied, which, as you see, may in somewhat extreme cases be twenty or thirty times the working pressure, what avails it that there is a factor of safety of 2 or 3?—disaster must follow.

"Now with direct current for long distance transmission there is no question about the electric pressure at the top and bottom of a wave being much greater than the mean pressure, no question about self-induction reducing the current—no objection, therefore, to putting the conductors as far apart as the risk of brush discharge may necessitate—no question about capacity current, no resonance troubles, etc.

"I wonder whether any of you are thinking—Well, perhaps there may be something in this heresy after all. No? Oh! then you are thinking, if the arguments were sound, the direct current system would have been already employed for long distance transmission? Well, but it has! Power up to 3,000 horse has been transmitted with direct current, at 14,000 volts, from Combe Garot to Le Locle and La Chaux de Fonds, round a circuit 32 miles long; 4,600 horse power has been transmitted with direct current, at 23,000 volts, 35 miles from St. Maurice to Lausanne; and a transmission system for 6,000 horse power, at 60,000 volts, over 114 miles from Moutiers to Lyons, is in course of construction.

"Another advantage that is possessed by all these examples of direct current transmission carried out by M. Thury is that it is the current that is kept constant and the electric pressure that is automatically raised when the demand for power is increased, whereas with the ordinary alternate current system it is the pressure at the lamp end that they aim at keeping constant, and the current that varies automatically with the demand for power.

"Now it is far more easy to maintain the constancy of the current flowing round a long circuit than to prevent the bobbing up and down of the electric pressure at the distant end of a long transmission line, and that irritating dancing of the lights, with which Johannesburg is so familiar, would be particularly difficult to avoid if the transmission line were long and the electric pressures at its two ends differed by some thousands of volts.

"Constant current has also its well known disadvantages, but these would not come into play if the constant current were not taken into houses, mines, etc., but used to drive motor generators in substations, the dynamo portion of the motor generator being of any type desired."

Taking into account the success which has been obtained with the electrical long-distance transmission of power in America the question naturally arises: Is such an industrial revolution in store for South Africa? At first sight such a transformation does not seem practicable, since South Africa has ample coal fields, and long-distance electric distribution does not appear to have much chance. It must be remembered, however, that in South Wales, and in the Tyne district, coal mining companies have found it to their advantage to take power from supply companies rather than to generate it for themselves, because the two industries of coal mining and power generation are distinct, and can be operated to better advantage separately than together. We know what has been done and what is under completion at Niagara, but at Niagara there is a large demand for power within reasonable distance, that there is small doubt that before long the hydraulic power there utilized will be five times as great as the total amount passing over the Victoria Falls in August, but no such demand exists in South Africa, and there is no prospect of its existence anywhere near the falls. Such a possibility may develop later in South Africa, but this does not appear at the present time, nor in the near future.

THE VIBRATIONS OF STEAMSHIPS.

APPARATUS FOR DETERMINING THE NATURE AND CAUSES OF VIBRATIONS AND THE PRACTICAL METHODS OF MINIMISING VIBRATORY ACTION.

Otto Schlick—Verein Deutscher Ingenieure.

WITH the increase in powering and speed of steamships there has appeared the necessity for considering the vibratory actions which result from the movements of reciprocating parts of the engines, the behaviour of the screw propellers, and the periodicity of the hulls of large vessels. Numerous attempts have been made to prevent or minimise such vibrations, and from the early experiments of Bourne and of Ericsson, nearly fifty years ago, down to the present, the problem has been studied and attacked in practice. Among those who have contributed largely toward the solution of this problem the name of Herr Otto Schlick is well known, and his work in connection with the *Bureau Veritas,* and with the machinery of the more recent steamers of the Hamburg-American line, has attracted interested attention in Europe and America. Since 1884, when he presented a paper upon the subject before the Institution of Naval Architects, he has been engaged in practical work in this line, and in a paper in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure* he examines the present state of the question, discussing especially the practical use of the pallograph, an instrument for recording and analysing the vibratory actions in steamers in actual service.

Herr Schlick refers to the behaviour of certain transatlantic steamers, notably the Normannia and the Fürst Bismarck, of the Hamburg-American line, and also mentions the experimental investigations made upon the Campania and Lucania, of the Cunard line. These latter experiments showed that the actual amplitude of the vibrations was much smaller than had been thought, and confirmed the fact that under ordinary conditions it is impossible to determine the nature and extent of such vibrations, owing to the absence of any stationary base for observation. It was soon found, however, that excessive vibration occurred when the period of the engines coincided with a vibration period of the hull, and in the case of the vessels just mentioned the vibrations were materially diminished by altering the pitch of the propellers in order to permit the number of revolutions of the engines to be changed to a speed out of harmony with the period of the hull, and this method has been used in the case of later vessels.

So far as the engines themselves are concerned, much has been accomplished during the past few years by the introduction of the system of balancing of the reciprocating masses by the corresponding modification of the crank angles, using four-crank engines. This system, the practical introduction of which is largely due to the work of Herr Schlick himself, is now becoming general on all large steamships, and it has done much to minimise the vibratory action of the engines. This method, however, does not entirely eliminate the vertical element, and in all cases the vibrations due to the action of the screw propellers remain to be considered.

Another question to be considered is the action of the two sets of engines in twin-screw propulsion, this being the arrangement which is almost invariably adopted in modern vessels. If it were possible to operate the separate engines driving the twin screws in such a manner that the piston positions would hold an invariable relation, the problem would be simplified, but in practice this is not possible, and the result is that the relations of the unbalanced elements of the two sets of engines do not hold a constant relation as regards the hull.

In order to minimise the action of the unbalanced action of the two sets of engines Herr Schlick assumes that each set of engines must be first balanced as fully as possible by the use of the four-crank system, the crank angles being determined so as to equalize the action of the inertia of the reciprocating parts as fully as possible. It then remains to so adjust the speed of rotation that the period of the hull and the disturbing influence of the propellers shall become a minimum, and this is a matter which demands the use of special investigating apparatus, after the vessel has been completed.

In order to investigate the nature and magnitude of the vibratory actions existing in a vessel, Herr Schlick has devised the apparatus which he has called the pallograph, this being a device in which the vertical and horizontal vibrations are separated and recorded upon a strip of paper moved by clockwork. The pallograph consists of four parts, the device for showing the vertical movement, the device for indicating the horizontal movement, the clockwork for moving the paper and marking the time intervals upon the record, and the electro-magnetic attachment for marking the crank positions on the paper. The vertical and horizontal movements are recorded by the use of levers carrying weights, the inertia of which opposes the motions of the hull, these being so suspended as to be capable of movement in the vertical and horizontal planes only, the action of the weights being opposed by helical springs. The fulcrums upon which the levers are suspended are adjustable so that the period of vibration of the apparatus may be made to coincide with the number of vibrations of the hull per minute, or with some exact multiple of it, and when so adjusted the device responds very vigorously to the vibrations of the vessel.

Since it is impracticable to insure the uniform feeding of the recording paper strip under all the conditions on shipboard, the apparatus is provided with a lever which marks every second on the paper, while another lever, operated by electro-magnetic contact with the engine shaft, records the position of the cranks, all the data for an investigation of the conditions of vibration being thus recorded.

In analysing the diagrams produced by the pallograph Herr Schlick recommends that the curves be enlarged photographically to about ten times their original dimensions, this enabling complex curves to be studied by the harmonic analysis and separated into their simple components. The analysis preferred by Herr Schlick is the graphical method of Dr. Fischer-Hinnen, of which he gives a detailed example.

By following the methods of adjusting the crank angles to equalize the action of the reciprocating masses, the vibrations due to a single engine of the four-crank type may be reduced to a minimum, but in the modern twin-screw steamship there are other causes of vibration which, if permitted to act in harmony with the period of the hull, may give rise to unpleasant effects. Thus it is practically impossible to maintain both sets of engines at the same speed and in the same phase relation, and while their unbalanced efforts may, in one phase oppose each other, the gradual shifting of this relation occurs until the effects reinforce, instead of neutralising each other, and thus marked periods of disturbances may occur.

Again, it is impracticable to construct all the blades of a screw propeller so exactly alike as to insure freedom from vibration in the water, and indeed it is not known to what extent the deflection and deformation of the blades under the heavy stresses to which they are subjected may alter their action.

Since the limitations of harbors and docks control to a large degree the proportions of the hulls of modern vessels, it is impossible to use entire freedom in design to meet the stresses. The depth of hull is limited by the maximum draught of the harbor entrances of the great seaports, so that increase in displacement must be mainly obtained by increased length and beam, and hence it is impracticable to construct ships with as great resistance to vertical as to horizontal stress. By the use of the pallograph the action of the forces upon the hull in relation to the propelling machinery at any moment may be determined, and an intelligent use of this important piece of apparatus should lead to continual progress in methods for overcoming the injurious and unpleasant vibrations so frequently observed.

ELECTRICITY AND POWER ENGINEERING.

THE INFLUENCE OF ELECTRICAL GENERATING AND TRANSMISSION APPLIANCES UPON THE DEVELOPMENT OF PRIME MOVERS.

W. B. Esson—Civil and Mechanical Engineers' Society.

THERE has been much written about the transformation of mechanical power into electrical energy, but the opposite side of the question, the influence which the development of electricity has had upon power machinery, has not been so fully considered. In the course of his presidential address before the Civil and Mechanical Engineers' Society, Mr. W. B. Esson referred to some interesting features in connection with this phase of the subject, and we give some of the salient points made by him.

After referring to the development of the dynamo, and to the impetus given to long distance transmission by the introduction of the transformer and the extension of high-voltage alternating currents, Mr. Esson showed the influence which these things have had upon power-generation and distribution. Thus, the ability to transmit power electrically has had a marked effect upon the use of water power, and from being a rather antiquated and limited sort of method the use of falling water as a source of energy has become enormously extended.

Referring to this feature, Mr. Esson says that it is not easy to estimate the total of the water power which has been utilised all over the world as a consequence of the erection of hydro-electric stations.

"I believe I am well within the mark in placing the total capacity of the hydro-electric power-houses at work and under construction on the American continent alone at a million horse-power. In Italy, Lombardy alone accounts for 88,000 horse power in hydro-electric power-houses at work and under construction, while Switzerland, the home of hydro-electrics, accounts for 220,000 horse power. Taking the whole world, the water power utilised in the hydro-electric stations must lie somewhere between a million and a half and two millions of horse power—a vast force the greater part of which might have run to waste for all time had it not been for the invention of the dynamo.

"All these schemes cannot be placed in the same category. Cases are numerous in which electricity is employed merely as a means whereby the power of water can be conveniently parcelled out to various industrial undertakings in the immediate neighbourhood. Such cases furnish an example of power distribution rather than of power transmission. The work is brought to the power, and the enterprise is of a kind differing entirely from those in which the power must be transmitted over a considerable distance, and in which by no possibility could the work ever be brought to its source. As furnishing a case of the former kind Niagara may be cited. The supply of cheap electrically distributed power has been the means of founding a most important industrial district and of increasing land values to a large extent. There is no doubt that here, though distance does not come in so much, electricity furnishes by far the best means of power distribution, but several other means have been proposed, and an altogether different problem is that of transmitting power to a distant region practically inaccessible so far as fuel is concerned on account of the enormous cost of transit. The works in the immediate neighbourhood of Niagara use about 60,000 horse power, and their demand continues all the year round without ceasing, the greater portion of the power being used for metallurgical and electro-chemical processes in the form in which it is received. The Niagara industries present the case of Mahomet going to the mountain, but amongst the cases of the mountain taking itself to Mahomet the transmission to the Kolar goldfield at Mysore already referred to furnishes a very good example. For years prior to 1899 the project of utilising the falls was discussed, but as often was it abandoned because of there being no local market for the power and no prospect of any industries being tempted to the district. But the falls were there with their huge power running to waste, and the Kolar goldfield was but 92 miles distant. Fuel in the mines was excessively dear, while the possibility of transmitting the power economically to great distances had been demonstrated in the case of other undertakings. The problem of utilising the power was in 1900 again taken up with all the knowledge which had been gained elsewhere brought to bear on it, and an enterprise is in full swing to-day by which 4,000 horse power is delivered to 10 mining companies in the Kolar fields, the revenues from which are sufficient to recoup the Mysore Government for the whole of its capital outlay in six years."

Naturally this growth in the use of hydraulic power has caused corresponding attention to be given to all departments of hydraulic engineering, and the subjects of water supply, of flow in channels, of penstock and pipe-line construction, and of all the details of heavy water-power plant have attracted renewed study and effort.

"Needless to say, turbine construction has been influenced to a very large extent by electric power development. Apart from the enormous amount of hydraulic engineering work represented by the utilisation of something between one and a half and two million horse power, the improvement in the efficiency of the turbine from the date of the Francis wheel must be credited directly to the great stimulus electric power work gave to turbine manufacture. While in 1870 the average power of each wheel made by one of the leading turbine firms was 70 horse power, in 1903 it was over 700 horse power, and the annual output in horse power had increased from 10,000 to 130,000. Twenty-five years ago the construction of a turbine giving 500 horse power was something of an achievement, to-day turbines are at work of 10,000 horse power. In all modern installations the electric generators are coupled direct to the turbine shafts. When it is possible, a horizontal shaft arrangement is chosen, though it is noteworthy that up to the present, owing to the special conditions to be met, the largest turbines have had vertical shafts. Generally the full-load turbine efficiency is about 80 per cent., though higher figures have been obtained, but the power of the wheel, the speed, and the fall all influence the useful return."

The relation of electrical development to the steam engine has been a rather curious one, and Mr. Esson discusses certain portions of the subject only. When the continuous-current dynamo was first made a practical machine it demanded high rotative speeds and close governing, and the result was an impetus to the manufacture of the short-stroke high-speed engine, especially of the single-valve automatic variety with shaft governor. The higher efficiency of the larger slow-running Corliss engine led to the modification of the dynamo to adapt it to this form of engine, and the development of the large alternator permitted the very effective combination of the generating set in which the rotor of the dynamo is incorporated with the flywheel of the engine.

Now, however, a second phase of the development has been entered and the success of the steam turbine is causing the alternator to be redesigned to adapt it to the high rotative speeds of the turbine, and thus the two arts of steam-engine building and dynamo design have reacted, each upon the other.

Another source of power, which is being adapted for the economical generation of electricity, is the gas engine. Since the application of the waste gases of blast furnaces as fuel for large gas engines has been successfully made it is evident that the supply of power gas is vastly greater than is needed for the mere driving of the furnace blowing engines. At the present time there are on the Continent probably not fewer than 100 gas engines averaging more than 500 horse power each in operation driving electric generators and furnishing current for power and lighting purposes about the works.

"On the Continent a number of installations have been erected in which the by-product gas from coke ovens is utilised to drive gas-engines. In the Ruhr coke-making district in Germany there is an aggregate of no less than 6,000 horse power produced by the utilisation of waste gases from the ovens. There are coked in this country annually about 50,000,000 tons of coal, and the gas from the coke ovens is capable of yielding in gas-engines 1,000,000 horse power continuously. In Germany and Sweden there are several works in operation producing power gas from peat. For the production of this gas the peat can contain as much as 45 to 50 per cent. of water, and it is not unlikely that there may be an opening here for the establishment of power stations near peat moors remote from coalfields. I have heard of a peat moor about 1¾ miles square capable of supplying enough gas to generate 10,000 horse power for 60 years. This may or may not be an exaggeration, but it is certain that there is enormous industrial waste in this country, and that true co-operation in the widest sense of the term between different industries would result in large savings."

STEEL FOR MOTOR-CAR CONSTRUCTION

NOTES ON ALLOY STEELS ESPECIALLY ADAPTED FOR USE IN THE CONSTRUCTION OF AUTOMOBILES AND INTERNAL COMBUSTION MOTORS.

Léon Guillet—Iron and Steel Institute.

THE development of new industries frequently reacts upon other lines of work, and often new demands appear which are met by correspondingly new products. It is not peculiar, therefore, that the growth of such an extensive department of work as the automobile industry should create a marked activity in the production of materials of construction of great strength, toughness, and capacity to resist shocks. When it is realized also that results rather than economy in first cost, are included in the demand, we need not be surprised to see the latest resources of the metallurgist drawn upon to supply materials to meet the exacting requirements of the automobile builders. The eminent French metallurgist, M. Léon Guillet, whose investigations upon the various alloy steels have attracted much attention, has devoted himself to this subject among others, and at the recent meeting of the Iron and Steel Institute he presented a paper upon the steels used in motor-car construction in France, which contained many points of interest and value, both to builders of automobiles, and to the engineering profession in general.

M. Guillet states that two groups of the various alloy steels have found applications in the construction of motor cars, these being the ternary steels, containing iron, carbon, and a third substance; and the quaternary steels, or alloys of iron, carbon, and two other substances. Under the first group he discusses the nickel steels, the chrome steels, and the silicon steels, these latter being frequently known as silicon-manganese steels. The quaternary steels actually in use are the chrome-nickel steels, and certain other alloy steels of which the composition is as yet kept secret. These steels do not include those employed for cutting tools in motor-car shops, the discussion being limited to actual materials of construction, forming portions of the completed vehicles.

In discussing the nickel steels, M. Guillet refers to a very common error, that of considering only the percentage of nickel, regardless of the carbon content. The mechanical properties of these alloys depend upon the relative carbon and nickel content, and to mention one without giving the other is meaningless. To speak of a 2 per cent. nickel steel without stating the percentage of carbon is to convey no real information whatever, and both proportions should always be given. In actual practice there are five nickel steels of practical value, as follows: Steels with low nickel (1 to 6 per cent.) and very low carbon (0.10 to 0.25 per cent.); Steels with low nickel (1 to 6 per cent.) and medium carbon (0.25 to 0.40 per cent.); Steels with medium nickel (10 to 18 per cent.) and with medium carbon (0.25 to 0.40 per cent.); High nickel steels (30 to 36 per cent.) with low carbon (0.12 to 0.20 per cent.); and High nickel steels (20 to 30 per cent.) and high carbon (0.60 to 0.80 per cent.).

The steels containing low nickel and low carbon are used in place of ordinary case hardened steel. The difficulties which are encountered with ordinary carbon steels in obtaining a hard exterior with a non-brittle interior are well known, but by the employment of the proper nickel steel these troubles may be wholly avoided. By taking a steel with 0.12 per cent. of carbon and 7 per cent. of nickel, and subjecting it to a cementation operation, so that the exterior contains from 0.90 to 1.0 per cent. of carbon, similar to ordinary case hardening, but without subsequent quenching, but on the contrary followed by a very careful slow cooling, an entirely satisfactory surface hardening is obtained. This process avoids all troubles from cracking or warping, and gives a hard exterior with a tough interior. This process, carried on under license of the De Dion Bouton Company, is extensively used for axles, crank shafts, and gears. Other low nickel steels, containing medium carbon, are used for journals and for axles, because of their strength and toughness.

The steel containing a high percentage of nickel and low carbon is chiefly known to engineers by the 36 per cent. alloy of Guillaume, this being the alloy of minimum expansion, used for tapes and wires for geodetic measurements because of its constancy in length under wide temperature changes. In the motor-car industry, however, steels containing low carbon and at least 32 per cent. of nickel are found to possess a very high degree of resistance to shock, and hence are especially adapted for valves. The fact that these alloys are untarnishable is also a valuable property in this connection.

Formerly the steels containing high nickel and high carbons were much used for crank shafts, valves, and other parts of automobiles, but M. Guillet points out serious disadvantages which they possess. Thus, in the course of the mechanical and thermal treatment necessary in working, they are apt to undergo transformations which materially reduce their resistance to shock, and as these changes cannot be determined during the course of the work the strength of the finished product remains uncertain. The high cost of such alloys also renders them undesirable, and they are being abandoned.

In regard to other ternary steels, M. Guillet mentions chrome steel, containing 1 to 1.2 per cent. of carbon and 1 to 2.5 per cent. of chromium, this being used for bearings. In order to avoid cracking, this alloy should be given a double quenching, first at 800° C. in oil, and then at 850° C. in water.

The silicon steel used for automobiles contains from 0.30 to 0.70 carbon and 2.5 to 0.80 per cent. silicon, the proportions of carbon and silicon varying inversely. It may also contain from 0.35 to 0.70 per cent. of manganese. Silicon steel is used for springs, and sometimes for gears.

Vanadium steel has not yet been used in automobile construction to any extent, but according to M. Guillet, it appears to be full of promise.

Of the quaternary steels, the chromium-nickel alloys are the principal ones having practical applications. Thus, a steel containing 0.25 to 0.45 carbon, 2.5 to 2.75 nickel, and chromium 0.275 to 0.60 per cent., gives, after quenching at 850° C. and reheating to 350° C., a certain degree of hardness, unaccompanied by brittleness, but with a very high elastic limit, so that it may be used without case hardening. Another combination, containing 0.25 to 0.45 carbon, 5 to 6 per cent. of nickel, and 0.5 to 1 per cent. chromium, is especially strong and tough after annealing at 850° C., and cooling in air, and is especially used for shafts and journals.

The medium and high nickel quaternary steels have not been found of much value in practice and are now little used.

M. Guillet mentions another quaternary steel, known to the trade as NY steel, the actual composition being kept secret. This is made by the Commentry-Fourchambault Company at their works at Imphy, and it appears to possess many valuable properties. Thus, before hardening it possesses all the qualities of a semi-hard steel, while after quenching at 850° C., without reheating it possesses the properties of quenched and reheated silicon steels.

Summing up, the special steels actually used in France in motor-car work are as follows:

Steels with low percentages of carbon and nickel (pearlitic steels) which are used for parts which require cementing and quenching, such as shafts, direct gears, etc.;

Steels with medium percentages of carbon and low percentages of nickel, used after quenching and reheating, for a large number of parts, shafts, gearing, pinions, etc.;

Steels low in carbon and with high percentages of nickel, used for valves;

Chromium steels, with high carbon and low chromium percentages, used for bearings;

Silicon steels, used for springs and for gearing;

Nickel-chromium steels, with low percentages of nickel and chromium, employed for numerous parts requiring resistance to shock and a certain degree of hardness.

To these may be added the new steel above mentioned, the composition of which has not yet been made public.

POWER-STATION DESIGN.

NOTES ON USEFUL DETAILS IN CONNECTION WITH THE DESIGN AND OPERATION OF POWER GENERATING STATIONS.

F. N. Bushnell—American Street Railway Association.

WHEN, at the present time, a power station is mentioned, the inference almost always follows that an electrical generating station is meant, and this conclusion will generally be found to be correct.

At the same time it must not be forgotten that electricity is not a source of power, but only a convenient means for transmitting the power generated from some other source to the point where it is to be converted into mechanical energy. In the paper by Mr. F. N. Bushnell, presented before the American Street Railway Association, the source of power is taken as steam, and when we consider that more than 90 per cent. of the power of the engines is electrically transmitted and delivered, it is evident that we must look for any gain in efficiency to other than the electrical departments.

There are other questions, however, besides economy in fuel which demand attention, one of these being the limitation of interruption to but a portion of the plant, and in this connection Mr. Bushnell describes the methods in use to prevent interruption to service.

"The practice of different engineers has gradually worked toward a type of station which is now so generally adopted for street railway work where limitations are not placed upon the design by the size or shape of the available site, that it can fairly be said to represent standard practice in modern power station engineering. In stations of very large size the boilers are frequently arranged in two tiers, or in groups, each group having its own chimney, and flues and independent systems of feed and steam piping. This arrangement is now generally referred to as the unit system, the distinguishing feature of which is that the boilers, engines and generating apparatus are arranged in separate units or groups, each of which embodies all of the essential features of a complete generating plant, and the great advantage of which lies in the fact that trouble with any single piece of apparatus is localized, so that its effect is felt only in that unit of which it forms a part. Provision for carrying the load in the event of a breakdown of any important part of the apparatus is made by installing an additional or spare unit.

"While the unit system is now almost universally employed in the larger power stations, it is usually somewhat modified for smaller plants where the liability to interruption of the service is not so great or the results so disastrous, the chief difference being in the arrangement of the steam and feed piping. The steam piping from the boilers is run to a longitudinal header, from which the connections to the engines are taken off at convenient points. This steam header is divided into sections by means of gate valves, which permit of any section being cut out at the convenience of the operator for the purpose of making repairs. Usually two systems of feed piping are provided, one of which supplies hot water to the boilers through the heaters and economizers, while the second, or auxiliary system, supplies cold water, or water direct from the heaters, in case of trouble with the main system. This arrangement of piping provides sufficiently against interruption in small and medium-sized plants, and in a system carefully laid out with due consideration for the troubles which are likely to arise, it is hardly probable that the disarrangement of any one part will cause serious interruption of the service."

In considering the arrangement of a power station, the question of system includes the proportion of the units to the work which is to be done, and this point is especially emphasised by Mr. Bushnell.

"The number and size of units to be installed is one of the most important problems bearing upon fuel economy which the engineer is called upon to solve. In order to obtain the maximum efficiency from the prime movers and their auxiliaries, it is necessary that they should be proportioned to the load they are intended to drive, so that if possible they may be operated at all times at or near their rated capacity.

'In electric railway power stations it is not regarded as practicable to change the speed of the air or circulating pumps, or to alter the quantity of cooling water, to suit the varying loads upon the station, and these auxiliaries are usually operated at a point sufficient to take care of the maximum load. The power required to drive them is therefore practically constant, and their steam consumption per unit of output will vary indirectly as the load on the main engines. Under ordinary operating conditions, where the exhaust steam is used for heating the feed water, only about 12 per cent. of the heat in the total steam generated can be used for this purpose, and all steam used by the auxiliaries in excess of this must go to waste; and it follows that in addition to the losses due to the reduced efficiency of the prime movers at light loads, the percentage of loss in the auxiliaries will increase very rapidly as the load upon the main engine decreases, and the best economy of the entire plant will be obtained only when the engines are operated at or slightly above their rated capacity."

Passing from the engine to the boiler room, it appears that the opportunity for improvement here lies with the furnace rather than with the boiler itself, since boiler efficiencies have already reached 75 to 80 per cent., giving little room for improvement. Here, probably, the best opportunities for economy are to be found in the prevention of leakages of cold air, in the proper mixture of air and fuel, and in the reduction of heat losses. By keeping accurate records of fuel consumption, flue gas, gas temperatures and composition, and rates of combustion the opportunities for economies in the combustion of the fuel should be detected and applied.

Mr. Bushnell is inclined to consider mechanical stokers as conducive to fuel economy, but above all he emphasises the importance of keeping regular records of coal and water consumption and of all the conditions surrounding the combustion of fuel.

THE ENGINEERING INDEX

THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

A Reinforced Concrete Bridge, Sorsogon, P. I. H. L. Stevens. Illustration and brief description of an arch bridge of 45-ft. span and 6-ft. rise. 600 w. Eng Rec—Oct. 21, 1905. No. 72804.

The Bridge over the Syra Valley at Plauen in Voigtland (Die Syratalbrücke in Plauen im Vogtlande). M. Foerster. A well illustrated description of the construction of this, the widest span masonry arch in the world, being 90 metres clear span. 2500 w. Schweiz Bauzeitung—Oct. 14, 1905. No. 72747 B.

The Proportions of Reinforced Concrete Arches (Dimensionierung der Betoneisernen Gewölbe). Dr. Max R. v. Thullie. Giving formulas and tables for practical use, together with a plate of curves for the graphical determination of the coefficients. 3500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 23, 1905. No. 72749 D.

Cantilever.

Cantilever Bridge of 1,800-Ft. Span Across the St. Lawrence. Illustrated detailed description of the bridge under construction near Quebec. 1200 w. Engng —Sept. 22, 1905. No. 72314 A.

Croton.

The New Croton Dam Bridge. Illustrates and describes the steel arch span across the spillway of the Croton reservoir. 2200 w. Eng Rec—Oct. 21, 1905. No. 72809.

Erection.

Assisted Cantilever Method. An illustrated explanation of this method as applied to the erection of permanent steel bridge work for the Western Maryland Railroad, Cumberland extension. 2000 w. Stevens Ind—July, 1905. No. 72828 D.

Havel.

The Iron Railway Bridge over the Havel at Brandenburg (Die Eisenbahnbrücke über die Havel bei Brandenburg). Karl Bernhard. With details of construction and erection of a semiparabolic truss of 90 metres span, with a peculiar form of bracing. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 14, 1905. No. 72731 D.

Housatonic.

A Through-Truss Short-Span Double-Track Bridge. Illustrated description of a bridge over the Housatonic River, south of Shelton, Conn., typical of the standard construction for that class on the N. Y., N. H., & H. R. R. 1800 w. Eng Rec—Oct. 21, 1905. No. 72808.

New York.

New York Bridges. Montgomery Schuyler. A critical review of the bridges across the East River and the Harlem River, noting their good and bad features. 2200 w. Arch Rec—Oct., 1905. No. 72390 C.

Plate Girders.

Some Deck Plate Girder Bridges on the New York, New Haven & Hartford R. R. Illustrations and information concerning these structures. 1600 w. Eng Rec—Sept. 30, 1905. No. 72366.

Some Through Plate-Girder Bridges, New York, New Haven & Hartford R. R. Gives brief illustrated descriptions of various types. 2000 w. Eng Rec—Oct. 7, 1905. No. 72486.

Variations in Standard Plans for Railroad Plate Girders. Frank W. Skinner. Gives a summary of the conditions relating to web stiffeners on different railroads. 2000 w. Eng Rec—Oct. 7, 1905. No. 72484.

Reconstruction.

Recent Bridge Work on the Nickel Plate. Albert J. Himes. An illustrated account of reconstruction work, replacing the early bridges which were unsuited to the present heavy traffic. 1800 w. R R Gaz—Vol. XXXIX., No. 15. No. 72509.

Steel Bridges.

Steel Railroad Bridges. A summary of replies to circular letters sent out by the Committee on Steel Bridges of the Association of Railway Superintendents of Bridges and Buildings. 1800 w. Eng Rec—Oct. 21, 1905. No. 72806.

Susquehanna.

The Havre de Grace Bridge of the Pennsylvania Railroad. Illustrated detailed description of an interesting bridge across the Susquehanna River, now under construction. It has a total length of 4,154 ft., with one drawspan of 280-ft. 1700 w. Ry Age—Oct. 6, 1905. No. 72422.

Transporter.

The Ferry Bridge Across the Ship Canal at Duluth, Minnesota. C. A. P. Turner. An account of the circumstances and conditions that influenced the selection of this type, with illustrated description of the structure, its construction, and operation. 5500 w. Pro Am Soc of Civ Engrs—Oct., 1905. No. 72831 E.

Viaduct.

The Concrete Railway Viaduct at Cannington. Gives data, concerning a viaduct built wholly of concrete, taken from a paper presented to the Inst. of Civ. Engrs. by Arthur Wood-Hill and Edward D. Pain. Ills. 2700 w. Eng Rec—Oct. 21, 1905. No. 72811.

CONSTRUCTION.

Building Details.

Structural Details of the General Electric Company's Power House, Schenectady. Illustrated description. 1800 w. Eng Rec—Sept. 30, 1905. Serial. 1st part. No. 72361.

Foundations.

Coaling Tower Foundations of the Union Electric Light & Power Co., St. Louis. An illustrated detailed description of difficult foundation work, owing principally to the nature of the ground and depth of water encountered. 2000 w. Eng Rec—Oct. 21, 1905. No. 72803.

Galleries.

Gallery Construction, Christ Church Memorial Building, New York. Illustrates details of the steel work, describing the construction. 700 w. Eng Rec—Oct. 21, 1905. No. 72810.

Gas-Holder.

Construction Details of a Modern Gas-Holder. Gives illustrated detailed description of the construction of one of six gas-holders recently built in New York City, and fairly typical of the best American practice. 2500 w. Eng News—Oct. 26, 1905. No. 72812.

Reinforced Concrete.

A Lighthouse of Reinforced Concrete. Translated from *La Nature*. Illustrated description of a lighthouse constructed by the Russian government at the entrance to the canal that connects the port of Nicolaief with the Black Sea. 1100 w. Sci Am Sup—Oct. 14, 1905. No. 72504.

Failure of the Roof of a Reservoir at Madrid (Effondrement de la Couverture d'un Reservoir d'Eau en Construction à Madrid). With illustrations showing the manner of failure of the reinforced concrete vaulting. 1800 w. Génie Civil—Sept. 23, 1905. No. 72709 D.

Reinforced Concrete as a Fire-Resistant. Reviews the rules of the Fire Offices Committee in London, and discusses their importance. 2400 w. Engng —Oct. 6, 1905. No. 72545 A.

Reinforced Concrete Construction. Lewis A. Hicks. Read at the Pac. Coast Eng. Cong., Portland. An examination of available data pertaining to the design of reinforced concrete cage construction. 9000 w. Jour of Elec—Oct., 1905. No. 72577 C.

Reinforced Concrete Shops and Car Houses, Central Pennsylvania Traction Co., Harrisburg. Mason D. Pratt. Illustrates and describes new buildings, built entirely of reinforced concrete, and covering an area of 53,000 sq. ft. 1400 w. Eng Rec—Sept. 30, 1905. No. 72363.

See also Civil Engineering, Bridges.

Tunnels.

Completion of Twin Tunnels Under the Hudson River. Illustrations and account of the completion of these tunnels connecting Jersey City with New York. 1100 w. Sci Am Sup—Oct. 14, 1905. No. 72505.

MATERIALS OF CONSTRUCTION.

Cement.

Methods of Testing and Some Peculiarities of Cement. W. A. Aiken. Read before the Assn. of Am. Portland Cement Mfrs. Outlines the methods of testing carried out by the Department of Inspection of Materials under the Board of Rapid Transit R. R. Commissioners of the City of New York. 3400 w. Cement Age—Oct., 1905. No. 72652.

Cement Plant.

The Works of the Kosmos Portland Cement Co. Illustrates and describes a plant in Kentucky and its equipment. 1800 w. Eng Rec—Oct. 21, 1905. No. 72807.

Concrete Blocks.

The Manufacture of Concrete Blocks and Their Use in Building Construction. H. H. Rice. (Prize paper.) Considers the materials, mixing, and manufacture of concrete blocks, the curing, facing, testing and cost, with suggestions for their use in construction. 7500 w. Eng News—Oct. 5, 1905. No. 72399.

The Manufacture of Concrete Blocks and Their Use in Building Construction. William M. Torrance. (Second prize paper.) Discusses the proper ingredients, forms of blocks, cost, engineering and architectural considerations, &c. Ills. 10000 w. Eng News—Oct. 12, 1905. No. 72496.

The Manufacture of Concrete Blocks and Their Use in Building Construction. Extracts from papers submitted to the *Engineering News* competition and not receiving prizes. Ills. 6000 w. Eng News—Oct. 26, 1905. No. 72814.

The Philadelphia Specifications for Concrete Building Blocks. Gives the regulations in force in the Borough of Manhattan, New York, and the rules and regulations covering the manufacture and use of concrete building blocks in the city of Philadelphia. 4200 w. Cement Age—Sept., 1905. No. 72409.

Fireproof Wood.

Results of Tests of Fireproof Wood at the Insurance Engineering Experiment Station. Report of Prof. Charles L. Norton, of tests made of specimens. 3500 w. Eng News—Oct. 5, 1905. No. 72404.

Lime.

The Analysis of Raw and Spent Lime. H. Leicester Greville. Describes the method devised by the writer for the analysis of spent lime, and the methods in use for the determination of free lime. 2200 w. Jour of Gas Lgt—Oct. 17, 1905. No. 72695 A.

Paving Materials.

The Importance of Preliminary Tests of Paving Materials. J. W. Howard. Read before the Am. Soc. for Munic. Imp. Urges the importance of making scientific tests of materials used and discusses briefly various kinds of pavement. 1500 w. Eng Rec—Oct. 7, 1905. No. 72488.

MEASUREMENT.

Surveying.

The Survey of the Kaiser Franz Josef I. Tunnel at Breth-Raibl (Die Achsabstechung des Kaiser Franz Josef I. Hilfsstollens in Breth-Raibl). Alois Plasser. With plan of the triangulation system used in connection with the running of a tunnel of 4,800 metres long in the Raibl lead and zinc mines. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 7, 1905. No. 72741 D.

MUNICIPAL.

Dust Prevention.

The Use of Oil on Macadam Pavements. Theodore F. White. Read before the Soc. of Munic. Imp. Gives the experience on California roads, and the satisfactory results obtained by asphalted macadam roads. 2000 w. Munic Engng—Oct., 1905. No. 72620 C.

London Traffic.

The Engineering of London Traffic. Editorial review of a recent report of the Royal Commission on London traffic by the advisory board of engineers. 3200 w. Engng—Oct. 13, 1905. No. 72687 A.

Manila, P. I.

Municipal Improvements in Progress and Projected at Manila, P. I. J. F. Case. Information concerning the scheme of improvements comprising the expenditure of about $6,000,000 within the next four years. Includes a sewer system, gravity water supply, bridges, &c. Explains the conditions to be met. 1500 w. Eng News—Oct. 19, 1905. No. 72587.

Mosquitoes.

A Review of the Anti-Mosquito Campaign. Edward S. Rankin. Read before the Am. Soc. of Munic. Imp. Principally an account of the work in New Jersey. 2000 w. Munic Engng—Oct., 1905. No. 72616 C.

Pavements.

Asphalt Paving. Andrew Rosewater. Condensed paper read before the Toledo convention of the League of Am. Munic. Discusses the construction, maintenance and cost. 3500 w. Munic Jour & Engr—Oct., 1905. No. 72324 C.

Effect of Water Upon Asphalts. A. W. Dow. A criticism of statements in a paper by Mr. Andrew Rosewater. 2500 w. Munic Engng—Oct., 1905. No. 72622 C.

Public Lighting.

Electricity v. Gas for Public Lighting. An explanation of the substitution in London and other English cities of gas for electric lights, and some information in regard to the comparative cost. 3500 w. Elec Rev, Lond—Oct. 6, 1905. No. 72539 A.

Refuse.

Disposition of Municipal Refuse. W. F. Morse. Read before the Am. Pub. Health Assn., at Boston. Describes American conditions, giving data from representative cities. 3200 w. Munic Jour & Engr—Oct., 1905. No. 72329 C.

The Incineration of Municipal Waste. Howard G. Bayles. Read before Am. Soc. of Munic. Imp. Gives information, gathered from various cities of the United States, as to efficiency, cost, and various features of the practice. 4000 w. Munic Engng—Oct., 1905. No. 72618 C.

Sanitation.

Sanitary Engineering in the Southern States. J. N. Hazlehurst. Read before the Am. Soc. of Munic. Imp. A brief general review of the work accomplished and an outline of the works being installed at New Orleans. 2200 w. Munic Engng—Oct., 1905. No. 72617 C.

Sewage Disposal.

Sewage Contact Beds Declared Superseded by Percolating or Sprinkling Filters. Prof. Bostock Hill. From a paper read before the British Assn. of Mgrs. of Sewage Disposal Works. Briefly discusses some important points in sewage disposal. 600 w. Eng News—Oct. 19, 1905. No. 72588.

Septic Tanks and Double Contact Beds at Burnley, England. Describes the sewage works of a cotton weaving town of about 100,000 inhabitants. They include large detritus tanks, septic tanks and double contact beds. 1700 w. Eng News—Oct. 26, 1905. No. 72813.

WATER SUPPLY.

Filtration.

The Mechanical Filters at Youngstown. Illustrated detailed description of a plant with a normal capacity of 10,000,000 gal. per 24 hours, built to treat the water of the Mahoning River. 3500 w. Eng Rec—Oct. 7, 1905. No. 72487.

Ground Water.

The Diminished Yield of Underground Waters in Southern California. Information from a report of W. C. Mendenhall, at the irrigation congress, showing a decline, and that it is time to stop increasing, indiscriminately, the number of wells. 3000 w. Eng Rec—Oct. 7, 1905. No. 72485.

Hydrants.

Freezing of Fire Hydrants. Gives information concerning the delays caused by frozen hydrants, resulting in great loss of property, considering modern hydrants to be the remedy. 3000 w. Ins Engng—Oct., 1905. No. 72826 C.

Intake.

The New Intake of the Erie Water Works. Describes the extension to the present intake which will draw the supply from Lake Erie instead of from Erie harbor. Ills. 3500 w. Eng Rec—Oct. 14, 1905. No. 72569.

Irrigation.

Irrigation Engineering. Sir Hanbury Brown. A discussion of the general principles on which the practice of irrigation is based. 3000 w. Engr, Lond—Oct. 20, 1905. Serial. 1st part. No. 72883 A.

The Buford Irrigation Project. General remarks on the extensive irrigation works undertaken by the U. S. Government, with illustrated description of this project in Montana, which contemplates the irrigation of about 60,000 acres of land. 1500 w. Engr, Lond—Sept. 29, 1905. No. 72479 A.

The Salt River Project, U. S. Reclamation Service. Illustrated description of the Roosevelt dam, Salt River, in connection with the irrigation development. 1800 w. Eng Rec—Oct. 14, 1905. No. 72566.

Montreal.

The Montreal Water Works. George Janin. Read before the Am. Soc. of Munic. Imp. Reviews the history of the water supply, and the plans for increasing it. 1800 w. Munic Engng—Oct., 1905. No. 72621 C.

Protection.

The Sanitary Protection of Water Supplies. Kenneth Allen. Considers means of detecting unsanitary conditions and corrective treatment. 9000 w. Jour Fr Inst—Oct., 1905. No. 72607 D.

Pumping.

See Mechanical Engng., Hydraulics.

Purification.

Purification of Water by Copper Sulphate. Daniel D. Jackson. Read before the Am. Soc. Munic. Imp. Gives results obtained by the writer in ponds and reservoirs showing this to be a satisfactory method of removing green growths. 1400 w. Munic Engng—Oct., 1905. No. 72615 C.

Water Purification Works for Toledo. Information concerning the 20,000,000-gal. mechanical filtration plant for the municipal water works in which work is to be started immediately. 1200 w. Eng Rec—Sept. 30, 1905. No. 72362.

Reservoir.

The Baden Reservoir of the St. Louis Water-Works. Illustrations and brief description of an interesting structure. 600 w. Eng Rec—Oct. 21, 1905. No. 72805.

Supplies.

Municipal Water Supplies. Hon. L. H. Chappell. Read before the League of Georgia Munic. Con. Discusses the requirements and methods. 2500 w. Munic Jour & Engr—Oct., 1905. No. 72328 C.

Water Tower.

A Novel Steel Tower and Concrete Platform for a Wood Stave Water Tank. Charles Worthington. Illustrates and describes a structure at Massena, N. Y., having novel features in framing believed to be advantageous and economical. 1200 w. Eng News—Oct. 26, 1905. No. 72815.

WATERWAYS AND HARBORS.

Antwerp.

The Port of Antwerp Extensions. Considers the present accommodations of this port and the enlargements proposed. Ills. 2800 w. Engng—Sept. 22, 1905. No. 72318 A.

Argentina.

Deep-Water Port at San Nicolas de los Arroyos (Puerto de Aguas Hondas en San Nicolas de los Arroyos). Details of proposed improvements of the port of San Nicolas, on the Parana river below Rosario. 3500 w. La Ingenieria—Aug. 30, 1905. No. 72775 D.

Chicago Canal.

Cost of the Chicago Drainage Canal. Gives a summary of receipts and expenditures taken from a recent report. 500 w. Eng News—Oct. 26, 1905. No. 72816.

Cranes.

Modern Slip Cranes (Neuere Helling Krane). Illustrating recent installations of traveling and derrick cranes for use on the slip ways of shipbuilding yards. 1200 w. Schiffbau——Sept. 27, 1905. No. 72768 D.

Sixty-Ton Floating Crane (Schwimmkran von 60 t. Tragfähigkeit). W. Pickersgill. Illustrating a powerful pontoon bridge crane for service in the harbor of Danzig. Details of the framing and machinery are given. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 30, 1905. No. 72704 D.

Danube.

Towing Tests on the Canal of the Iron Gates (Mitteilungen über die am Eisernen Tor Durchgeführten Schiffszugsversuche). Alois Hoszpotzky. Data and results of dynamometer tests of the power required to tow boats up against the current in the canalized Danube at the Iron Gates. 8000 w. 3 plates. Oesterr Wochenschr f d Oeffent Baudienst—Oct. 14, 1905. No. 72751 D.

Dredges.

Combined Bucket and Suction Dredge. Illustrated description of an interesting dredging vessel built in Holland for service at Monte Video, Uruguay. 1000 w. Naut Gaz—Oct. 19, 1905. No. 72634.

Dredging by Hydraulic Method. G. W. Catt. Briefly describes various types of dredges used for excavating in rivers and harbors, and gives illustrated description of methods and apparatus used in hydraulic dredging. 3500 w. Iowa Engr—March, 1905. No. 72833 C.

United States Dredge Barnard. Robert S. Riley. Illustrated detailed description of a dredge designed to help open and maintain the new channel for navigation through the delta of the Mississippi River. 4000 w. Marine Engng—Oct., 1905. No. 72337 C.

Graving Dock.

A New Graving Dock at Nagasaki, Japan. Naoji Shiraishi. Dimensions, general information, and illustrated description. 1800 w. Pro Am Soc of Civ Engrs—Oct., 1905. No. 72832 E.

New Graving Dock at Southampton. Brief description, with cross-section, of the recently completed dock for the London and South-Western Railway Company. 1100 w. Engng—Oct. 20, 1905. No. 72877 A.

New Graving Dock at Southampton. Illustrated detailed description of this new dock, which is one of the largest of the kind in Europe and in the world. 1800 w. Engr, Lond—Oct. 20, 1905. No. 72888 A.

Panama.

Conditions at Panama as Seen by a Member of the Consulting Board of Engineers. A letter from Mr. Isham Randolph describing the conditions. 1500 w. Eng News—Oct. 26, 1905. No. 72817.

The First Year's Preparatory Work on the Panama Canal. John F. Wallace. Mr. Wallace's third article gives a summary of the actual construction work accomplished during the year in which he was in charge, and shows the actual costs and the difficulties to be overcome. 4500 w. Engineering Magazine—Nov., 1905. No. 72786 B.

The Present Status of the Panama Canal. Fullerton L. Waldo. A review of the work accomplished, discussing the sites for dams, the plans proposed for sea-level and for lock canals, and the reports of investigators. 4000 w. Eng Rec—Oct. 7, 1905. No. 72483.

Ports.

The Accessibility of Ports. Brysson Cunningham. Discusses the location, environment, approach channel, and climatic conditions in relation to their influence on the accessibility. 3500 w. Engng—Oct. 13, 1905. No. 72683 A.

River Regulation.

The Work of the Commission for the Regulation of the Moldau and the Elbe in Bohemia in 1904 (Die Tätigkeit der Kommission für die Kanalisierung des Moldau und Elbeflusses in Böhmen im Jahre 1904). H. Franz. Details of the progress of the work, with illustrations of locks, movable dams, etc. 3500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Oct. 7, 1905. No. 72750 D.

Trieste.

The Improvement of the Harbor of Trieste according to the Projects of 1903 (Ueber die Ausgestaltung des Hafens von Triest nach dem Projekte 1903). Nandor Nadory. A critical discussion of the various plans proposed, pointing out their defects. Serial. Part I. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 13, 1905. No. 72783 D.

Venice.

The Port of Venice (Per il Porto di Venezia). A comparative study of the various plans now under consideration for the improvement of the harbor facilities of Venice. 4000 w. Monitore Tecnico—Sept. 20, 1905. No. 72779 D.

Weir.

Constructing a Submerged Weir by Overturning a Tower of Concrete Blocks. Drawings and brief description of a novel scheme devised for a submerged weir in the rapid current of the Niagara River. 400 w. Eng News—Oct. 12, 1905. No. 72497.

MISCELLANY.

Draining.

Drain Tile Laying. Gilmer Siler. The present article considers the essential characteristics of a good drain tile, the various sizes and their capacity of flow, how lands should be drained and best practice in laying tile. 2500 w. Brick—Oct., 1905. Serial. 1st part. No. 72491.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchanges.

Fire Protection in Telephone Exchanges. H. S. Knowlton. Mentions some practices that deserve criticism, and discusses the necessity for the proper maintenance of fire-protection apparatus. 1800 w. Am Elect'n—Oct., 1905. No. 72383.

Fire Alarms.

Fire Alarm Telegraph Systems. William Brophy. Read before the Int. Assn.

of Munic. Elect'ns. Suggests some improvements needed, but considers the present system excellent. 5000 w. Ins Engng—Oct., 1905. No. 72825 C.

The Fire-Alarm Telegraph Service in Greater New York. An investigation and report by the committee on fire-alarm service for the borough of Manhattan of the New York board of fire underwriters. Ills. 4500 w. Elec Rev, N Y—Oct. 14, 1905. No. 72527.

Printing Telegraph.

The Siemens & Halske Printing Telegraphic Apparatus. Emile Guarini. Illustrated description of the automatic printing telegraph system recently brought out by this firm. 1100 w. Elec Rev, Lond—Sept. 22, 1905. No. 72308 A.

Space Telegraphy.

Interference in Wireless Telegraphy. John Stone Stone. Abstract of a paper read before the Canadian Soc. of Civ. Engrs. An explanation of the manner of developing persistent trains of simple harmonic electro-magnetic waves of one frequency to the exclusion of waves of other frequencies. 3500 w. Sci Am Sup—Oct. 7, 1905. No. 72447.

Recent Advances in Selective Wireless Telegraphy. Editorial reviewing recent progress in sending messages in a given direction, and inventions of importance in this field. 1100 w. Sci Am—Oct. 17, 1905. No. 72444.

Wireless Telegraphy. W. Duddell. Condensed lecture delivered at Olympia, reviewing the history and referring to the work of various investigators. 3000 w. Elec Engr, Lond—Oct. 6, 1905. No. 72531 A.

Telautograph.

The Telautograph. H. I. English. Brief account of the invention and development of the Gray telautograph, dealing especially with its present commercial form. 3400 w. Jour Fr Inst—Oct., 1905. No. 72605 D.

DISTRIBUTION.

Accumulators.

High Pressure Accumulators (Ueber Hochspannungs-Batterien). L. Schröder. Details of construction and operation of an accumulator charged at 3,000 volts; special reference is made to the insulation. Zeitschr f Elektrotechnik—Oct. 15, 1905. No. 72772 D.

See also Electrical Engineering, Electrochemistry.

Cables.

The Manufacture and Application of Coverings for Cables (Ueber Kabelschützhüllen, deren Herstellung und Verlegung). J. Schmidt. Describing various methods of protecting underground cables from injury, with illustrations and details of costs. 3000 w. Elektrotech Zeitschr—Oct. 5, 1905. No. 72760 B.

Circuit Breaking.

High Tension Circuit Breaking Devices. W. T. Fernandez. Describes the mechanical and electrical features of several types of oil-break switches. Ills. 1600 w. Am Elect'n—Oct., 1905. No. 72386.

Converters.

Recent Converter Installations (Neuere Umformungsanlagen). F. Collischonn. Illustrating and describing several large motor-generators and rotary converters recently erected in Germany. 4000 w. Elektrotech Zeitschr—Sept. 21, 1905. No. 72752 B.

The Cascade Converter. A description of a combination of an induction motor and a synchronous converter. The machine is designed for the transformation of alternating into direct current. Also editorial. 1700 w. Elec Wld & Engr—Oct. 21, 1905. No. 72657.

Discussions.

Discussion on, "High Power Surges in Electric Distribution Systems of Great Magnitude," and "An Experimental Study of the Rise of Potential on Commercial Transmission Lines, Due to Static Disturbances such as Switching, Grounding, etc.," at Asheville, N. C. 7500 w. Am Inst of Elec Engrs—Sept., 1905. No. 72836 D.

Fuses.

Standardization of Enclosed Fuses. H. O. Lacount. Discusses the necessity of standardizing enclosed fuses, the work of standardizing, the results of this work, and the tests of enclosed fuse designed to comply with the specifications. 6000 w. Am Inst of Elec Engrs—Sept., 1905. No. 72842 D.

Reliability.

Discussion on, "Time Limit Relays," and "Duplication of Electrical Apparatus to Secure Reliability of Service," at New York, May 16, 1905. 6000 w. Am Inst of Elec Engrs—Sept., 1905. No. 72855 D.

The Moscow-Road Sub-Station of the Metropolitan Electric Supply Co. Illustrated description. 1500 w. Elect'n, Lond—Oct. 13, 1905. No. 72681 A.

The Westminster Electric Supply Co.'s "Italian Garden" Sub-Station. Illustrated description of a sub-station in Grosvenor-Square, London, where the station is in the basement, and the roof forms the Italian garden, at a level of some 8 ft. above the street. 3700 w. Elect'n, Lond—Sept. 22, 1905. No. 72309 A.

Substation.

The Monbijou Transformer Station (Die Umformerstation Monbijou). S. Herzog. An illustrated description of the substation in the city of Berne, receiving an alternating current at 16,000 volts from the Kander hydro-electric station, and transforming it to 120 volts continuous for local distribution. 2000 w. Zeitschr f Elektrotechnik—Oct. 8, 1905. No. 72767 D.

Three Wire.

Bare or Insulated Third Wires (Zur Frage des Blanken oder Isolierten Mittelleiters). Fr. Erens. A discussion showing the desirability of insulating the neutral wire in three-wire distribution systems. 3500 w. Elektrotech Zeitschr—Sept. 28, 1905. No. 72756 B.

Notes on Certain Three-Wire Systems. Charles T. Hosman. Read before the Ohio Elec. Soc. Considers points in direct-current lighting and power work. 2500 w. Engr, U S A—Oct. 2, 1905. No. 72345 C.

Transformers.

Calculation of Alternate-Current Transformers for Minimum Cost. Dr. R. Pohl and H. Bohle. Discusses the constructing of a transformer at a minimum cost for a given efficiency. Describes method entirely devoid of mathematical difficulties. 1500 w. Elec Engr, Lond—Sept. 29, 1905. Serial. 1st part. No. 72463 A.

Experience on the Road. G. B. Rosenblatt. An account of an interesting incident with water-cooled transformers, explaining the cause of the trouble. 1200 w. Elect Jour—Oct., 1905. No. 72602.

The Proportions of Transformers Involving a Minimum Cost for Materials (Berechnung von Transformatoren auf den Mindestbetrag an Kosten des Wirksamen Materials). Dr. R. Pohl & Hermann Bohle. Deriving formulas and graphical diagrams for simplifying the practical calculations required for construction. 4000 w. Elektrotech Zeitschr—Sept. 28, 1905. No. 72755 B.

See also Electrical Engineering, Generating Stations.

ELECTRO-CHEMISTRY.

Bichromate Batteries.

A New Form of Cell. Walter P. White. Calls attention to a device for supporting the zinc in such cells. Ills. 700 w. Sci Am Sup—Oct. 21, 1905. No. 72594.

Chemistry.

The Chemistry of Electro-Chemistry. Wilder D. Bancroft. Read before the Am. Elec.-Chem. Soc. A study of electrochemical phenomena with special reference to chemistry. 6000 w. Elec Rev, N Y—Oct. 7, 1905. No. 72434.

Electric Smelting.

Recent Advances in the Electro-Metallurgy of Iron and Steel. R. S. Hutton. Abstract of a paper in *Jour. Soc. of Chem. Ind.* Reviews the electric-furnace methods and what has been accomplished in electric steel production, discussing the outlook. 1300 w. Eng & Min Jour—Oct. 28, 1905. No. 72849.

The Kjellin Electric Steel Furnace. Translated from *Stahl und Eisen.* V. Engelhardt. An illustrated account of the plant at Gysinge, Sweden, and its operation. 4500 w. Ir Age—Oct. 19, 1905. No. 72573.

Electro-Metallurgy.

Some Notes on the Rapid Electro-Deposition of Copper. Sherard Cowper-Coles. Abstract of a paper before the Faraday Soc. Reports results of experiments on the electrolytic production of copper tubes; also considers the production of copper wire by electrolytic means. 900 w. Elec Rev, N Y—Oct. 7, 1905. No. 72435.

The Hoho Process of Heating and Working Metals by Electricity. Paul Hoho. Outlines the principal characteristics of this process, discussing its practical applications. 2200 w. Elec Wld & Engr—Sept. 30, 1905. No. 72389.

Solutions.

Molecules in Solution. Editorial review of paper by G. T. Beilby before the British Assn. Considers some aspects of extreme dilution, and the explanation of the physical properties of liquids. Discusses the case of gold contained in sea water. 2500 w. Engng—Sept. 29, 1905. No. 72473 A.

Storage Batteries.

Storage Batteries and Their Electrolytes. R. W. Vicarey. Abstract of a paper before the Faraday Soc. Gives a résumé of data and facts from actual practice, and much information of value. 8000 w. Elect'n, Lond—Sept. 29, 1905. No. 72470 A.

ELECTRO-PHYSICS.

Dielectrics.

Contact with Dielectrics. Rollo Appleyard. Communicated to the *Philosophical Mag.* by the Physical Soc. A report of experimental investigations with results and conclusions. 4000 w. Elect'n, Lond—Oct. 6, 1905. No. 72542 A.

Eddy-Current Losses.

Eddy-Current Losses in Armature Conductors. Gives details taken from an article in the *Elektrotechnische Zeitschrift* describing experiments carried out by B. Loewenherz and A. Van der Hoop. Ills. 700 w. Elec Engr, Lond—Sept. 29, 1905. No. 72464 A.

Electromagnets.

The Design of Multiple-Coil Windings. Charles R. Underhill. Explains the principle of the multiple-coil winding for electro-magnets, and the method of ascertaining the safe current carrying capacity of the winding. 1000 w. Elec Wld & Engr—Oct. 14, 1905. No. 72565.

Fog-Dispelling.

Lodge's Fog-Dispelling Apparatus. Abstract of specifications of an invention of Sir Oliver J. Lodge, for "improvements in means for the production of continuous high potential electrical discharges applicable for the deposition of dust, fume, smoke, fog and mist, for the production of rain and for other purposes." 1200 w. Sci Am Sup—Oct. 21, 1905. No. 72593.

Insulation.

Insulating Paints. Arthur B. Weeks. Discusses some of the qualities of a good paint, means of testing, &c. 1800 w. St Ry Rev—Oct., 1905. No. 72638 C.

On the Ratio Between Thickness and Dielectric Strength of High-Tension Insulating Materials. C. Kinzbrunner. Describes experimental investigations. 1500 w. Elect'n, Lond—Sept. 29, 1905. Serial. 1st part. No. 72468 A.

Radium.

Recent Study of Radium. Editorial review of recent papers appearing in the *Philosophical Mag.* giving results of experimental research of much value. 2000 w. Engng—Oct. 20, 1905. No. 72879 A.

GENERATING STATIONS.

Central Station.

The Central Heating and Electric Lighting Station at Dresden. An illustrated account of a central heating station where the results obtained have been exceptionally good. 2200 w. Engr, Lond—Oct. 6, 1905. Serial. 1st part. No. 72550 A.

Combined Plant.

Electric Light, Water Works and Central Hot-Water Heating Installation at Ada, O. A. E. Buchenberg. A general illustrated description of a successful installation. 1600 w. Elec Wld & Engr—Sept. 30, 1905. No. 72388.

Design.

Modern Power-Plant Design and Economics. Franz Koester. Mr. Koester's fourth paper treats of the electrical equipment of the generating room installation and operation. 3000 w. Engineering Magazine—Nov., 1905. No. 72788 B.

The Power Station. Fred N. Bushnell. Read before the Am. Ry. Mech. & Elec. Assn. Also editorial. Discusses problems and development in power station design and operation. Ills. 9800 w. Elec Rev, N Y—Oct. 21, 1905. No. 72653.

Dynamos.

Characteristics of Dynamos. E. B. Raymond. Explains the plotting of curves of series dynamos, shunt dynamos, &c. Diagrams. 1500 w. Engr, U S A—Oct. 16, 1905. No. 72563 C.

Dynamo Heating Time Constants. Explains method of calculation. 600 w. Elec Wld & Engr—Oct. 28, 1905. No. 72857.

Notes on the Design of Continuous-Current Dynamos (Beitrag zum Entwurf von Gleichstrommaschinen). Arthur Müller. A mathematical examination of the controlling elements affecting the proportions of dynamos for continuous currents. 3500 w. Zeitschr f Elektrotechnik—Oct. 1, 1905. No. 72766 D.

The Alternating Current Generator. David B. Rushmore. Historical sketch of the origin, development and present status of this important class of electric generators. Ills. 4500 w. Jour Fr Inst—Oct., 1905. No. 72606 D.

Equipment.

Uniform Equipment in Electric Power Plants. H. S. Knowlton. Presents the advantages of uniform equipment. 1400 w. Cassier's Mag—Oct., 1905. No. 72624 B.

Hartford.

Electrical Supply in Hartford. Describes the Hartford, Conn., system, which derives its energy from the Farmington River, and steam power. Curves are given showing the rise of output since 1898. 1600 w. Elec Wld & Engr—Oct. 21, 1905. No. 72654.

Hydro-Electric.

A Review of the Hydraulic Plant in the Canton of Fribourg, Switzerland (Aperçu Historique des Installations Hydrauliques dans le Canton de Fribourg). F. de Reyff. An illustrated review of the utilization of the mountain streams of the canton, with details of generating and distributing plants. Serial. Part I. 4000 w. Bull Tech de la Suisse Romande—Sept. 25, 1905. No. 72776 D.

The Electric Station of the City of Brixen, on the Rienz (Rienzwerke Elektrizitätswerk der Stadt Brixen). Gustav Witz. With details of the hydraulic and electric plant, turbine regulation, and building construction of the electric plant of Brixen, in Tyrol. 4000 w. 1 plate. Zeitsch d Oesterr Ing u Arch Ver—Oct. 6, 1905. No. 72715 D.

The Largest Hydroelectric Installation in Southern Asia. A. C. Hobble. Illustrates and describes the interesting engineering features of the Couvery power scheme and the industrial applications in India. 1500 w. Elec Rev, N Y—Oct. 14, 1905. Serial. 1st part. No. 72528.

Water Power Plants on the Apple River, Wisconsin. Illustrates and describes the plant of the Apple River Power Co. comprising two water-power electric generating stations and a high-tension transmission line. The two plants are run in multiple with each other. 3000 w. Eng News—Oct. 12, 1905. No. 72499.

Isolated Plants.

Isolated Plant Engineering. James F. Hobart. Calls attention to points needing attention in such plants, giving suggestions for the best care of the plant. 2200 w. Am Elect'n—Oct., 1905. No. 72385.

Power for Sydney University. E. Kilburn Scott. Read before the Univ. Engng. Soc. Describes a proposed scheme for a power station to meet the needs of the University. 5500 w. Aust Min Stand—Aug. 25, and 30, 1905. Serial. 2 parts. No. 72370 each B.

Lancashire.

Lancashire Electric Power Co.'s System of Generation and Distribution. Illustrates and describes this system which is the first electric power undertaking in England to work with 10,000 volt overhead bare conductors. Also editorial. 3000 w. Elect'n, Lond—Oct. 13, 1905. No. 72682 A.

Load Factor.

The Load Factor of Electric Generating Stations (Der Belastungsfaktor Elektrischer Beleuchtungszentralen). Norberg Schulz. A discussion of the operation of the generating station at Kristiania, Norway, with load curves and load-factor diagrams. 3000 w. Elektrotech Zeitschr—Oct. 5, 1905. No. 72758 B.

Phase Regulator.

A Proposed Phase Regulator and Its Applications. P. G. Watmough, Jr. Presents only the general principles and applications of the device for adjusting the phase displacement of a generator or other alternating-current apparatus. 1800 w. Elec Wld & Engr—Oct. 21, 1905. No. 72655.

Switch Gear.

The New Ferranti Switch Gear. Illustrates and describes this switch gear, which has been almost entirely remodelled to meet the conditions of modern generating stations. 3000 w. Elect'n, Lond—Oct. 20, 1905. No. 72870 A.

Tunnels.

Latest Electrical Equipment of the Karawanken Tunnel. F. C. Perkins. Describes briefly the electrical power transmission plants and equipments utilized for the construction of this tunnel in Austria-Hungary. 1500 w. Min & Sci Pr—Oct. 21, 1905. No. 72893.

United States.

Central Electric Light and Power Stations in the United States. From a report published by the Bureau of the Census, giving statistics of interest, showing the growth of this industry. 2300 w. Eng Rec—Sept. 30, 1905. No. 72365.

Utah.

The Utah Light & Railway Co. O. A. Honnold. History and description of the engineering and operating features of a system uniting several generating stations by one transmission network. Ills. 5000 w. St. Ry Rev—Oct., 1905. No. 72635 C.

Voltage.

The Selection of Working Voltage for a New Electric Plant (Die Wahl der Verbrauchsspannung für Neu Anzulegende Elektrizitätswerke). E. Wikander. A comparison of the relative advantages of various pressures for continuous and alternating currents. 3000 w. Elektrotech Zeitschr—Oct. 12, 1905. No. 72763 B.

See also Street and Electric Railways.

LIGHTING.

Alternating Arcs.

The Relation Between Current and Voltage in the Alternating Arc. Abstract translation of an article by H. T. Simon. An illustrated study of the arc, showing the necessity of using the dynamic characteristic in considering alternating currents. 2500 w. Elec Engr, Lond—Oct. 20, 1905. No. 72868 A.

Electric Projection.

Some New German Electric Projection Apparatus. C. J. Smith. Illustrates and describes devices for electrical projection of transparent and opaque bodies, as well as for colored projection, combined with searchlight and lantern effects. 1000 w. Elec Wld & Engr—Oct. 28, 1905. No. 72858.

Exhibition.

Recent Progress in Electric Lighting as Indicated by the Olympia Exhibition. Francis H. Davies. Remarks on improvements during recent years, and description of exhibits of various types of lamps. 2000 w. Elec Engr, Lond—Sept. 29, 1905. Serial. 1st part. No. 72461 A.

Lamps.

Notes on the Selection of Incandescent Lamps. J. E. Dawson. Discusses schemes for the maintenance and renewal of lamps, and the difficulties. 1100 w. Elec Rev, Lond—Oct. 13, 1905. No. 72679 A.

Street Lighting.

Systems of Electric Street Lighting. E. A. Fisher. Read before the Am. Soc. of Munic. Imp. Discusses only the arc lamps, considering the service, cost, &c., giving statistics of the systems in use. 3500 w. Munic Engng—Oct., 1905. No. 72619 C.

Tantalum.

The Tantalum Lamp (Ueber die Tantallampe). W. Wedding. Diagrams and tables of tests, showing the superiority of the tantalum to the carbon incandescent lamp. 2500 w. Elektrotech Zeitschr—Oct. 12, 1905. No. 72762 B.

MEASUREMENT.

Discussion.

Discussion on, "Methods of Measurement of High Electrical Pressures," at Asheville, N. C. 3800 w. Am Inst of Elec Engrs—Sept., 1905. No. 72837 D.

Oscillograph.

The Kathode Ray Oscillograph. Robert Rankin. Describes improvements made in a familiar type of oscillograph which have made it an inexpensive and reliable curve tracer. Gives experiments illustrating its use. Ills. 3000 w. Elec Jour—Oct., 1905. No. 72604.

Photometry.

The Calculation of Mean Spherical Candle Power. Lancelot W. Wild. Describes a method of calculating not generally known. 1200 w. Elect'n, Lond—Sept. 29, 1905. No. 72467 A.

Reichsanstalt.

The Work of the Physical Technical Reichsanstalt in 1904 (Die Tätigkeit der Physikalisch-Technischen Reichsanstalt im Jahre 1904). An abstract of that portion of the report relating to the standardizing of electrical appliances and methods. 6000 w. Elektrotech Zeitschr—Sept. 21, 1905. No. 72754 B.

Self-Induction.

A New Method for Determining Coefficients of Self-Induction (Neues Verfahren zur Bestimmung von Selbstinduktionskoeffizienten). W. Peukert. The attraction between two coils is measured by a beam balance, in connection with a variable capacity and resistance. 1800 w. Elektrotech Zeitschr—Oct. 5, 1905. No. 72759 B.

MOTORS.

Automobile Motors.

Speed-Time Curves for Automobile Motors. Frank B. Rae. Gives curves showing graphically the current input required for a given weight and rate of acceleration and for running at speed, with calculations. 2500 w. Elec Wld & Engr—Oct. 21, 1905. No. 72656.

Discussion.

Discussion on "Synchronous Converters and Motor-Generators," at Asheville, N. C. 4500 w. Am Inst of Elec Engrs—Sept., 1905. No. 72841 D.

Exhibition.

Alternate-Current Machinery at Olympia. P. R. Friedlander. Principally illustrating and describing single-phase and three-phase motors of recent design at the Olympia exhibition. 2000 w. Elec Engr, Lond—Oct. 6, 1905. No. 72530 A.

Direct-Current Machinery at Olympia. P. K. Friedlander. Remarks on the machines shown at the electrical exhibition. Ills. 1800 w. Elec Engr, Lond—Sept. 29, 1905. No. 72460 A.

Induction Motors.

Air-Gap Flux in Induction Motors. A. S. Langsdorf. Report of an investigation made to study the effect upon the flux distribution of varying numbers of teeth in the stator. 1400 w. Am Inst of Elec Egnrs—Sept., 1905. No. 72843 D.

Interpole Motor.

The Morris-Hawkins Inter-pole Motor. Illustrated description of motors which, it is claimed, run sparklessly on all loads with brushes fixed in the neutral position. 800 w. Engng—Sept. 29, 1905. No. 72475 A.

Single-Phase.

Single-Phase Alternating-Current Motors. G. Percy Cole. Abstract of a paper read before the Ohio Elec. Lgt. Assn. Reviews the development of these motors, and describes the Schuler type and the compensated series types for variable speed service. Ills. 2500 w. Engr, U S A—Oct. 2, 1905. No. 72346 C.

Sparking.

Discussion on "Limits of Injurious Sparking in Direct-Current Commutation," at Asheville, N. C. 3000 w. Am Inst of Elec Engrs—Sept., 1905. No. 72840 D.

TRANSMISSION.

France.

A 20,000 Volt Power Transmission Scheme. Illustrated description of a new water-power scheme inaugurated at Clermond-Ferrand, in France. 2500 w. Elect'n, Lond—Oct. 6, 1905. No. 72540 A.

Insulation.

The Testing of High-Pressure Insulating Materials (Die Prüfung von Hochspannungs-Isolationsmaterialien). C. Kinsbrunner. Giving curves showing the time endurance of various insulating materials under different voltages. 2000 w. Zeitschr f Elektrotechnik—Sept. 17, 1905. No. 72764 D.

Lightning Arresters.

Protective Apparatus. N. J. Neall. Illustrates and describes various designs of choke coils for use in connection with lightning arresters. 1400 w. Elec Jour —Oct., 1905. No. 72603.

Long Distance.

The Distribution of Power. Prof. W. E. Ayrton. Abstract of a lecture delivered at the meeting of the British Assn., in South Africa. Reports an interesting lecture in which the use of high-tension continuous current for long-distance transmission is advocated. Also editorial. 6200 w. Elect'n, Lond—Sept. 22, 1905. No. 72310 A.

Mexico.

Development of the Necaxa, Mexico, Water Power. Illustrated detailed description of a great power transmission system, notable for its size and for constructional features of interest. 2000 w. Elec Wld & Engr—Oct. 28, 1905. No. 72856.

Poles.

Cement Feet for Wooden Poles (Zementfüsse für Holzmasten). S. Herzog. Describing a system for protecting the bases of wooden poles from moisture and consequent decay. 1200 w. Zeitschr f Elektrotechnik—Sept. 24, 1905. No. 72765 D.

Single-Phase.

Single-Phase v. Polyphase Transmission Lines. H. S. Watson. Presents arguments in favor of single-phase transmission. 1000 w. Elect'n, Lond—Oct. 6, 1905. No. 72541 A.

MISCELLANY.

Address.

The Influence of Electricity on Power Engineering. W. B. Esson. Presidential address to the Civ. & Mech. Engrs.' Soc. Historical review of the progress and development, with discussion of topics of special interest. 5500 w. Elec Engr, Lond—Oct. 13, 1905. Serial. 1st part. No. 72677 A.

Electric Heating.

The Development of Electric Heating. A. E. Jepson. Abstract of a paper read before the Manchester students' section of the Inst. of Elec. Engrs. Briefly refers to the early applications, the recent development, the various systems in use at the present time, &c. Ills. 5400 w. Mech Engr—Oct. 7, 1905. No. 72538 A.

Electric Shock.

Resuscitation from Electric Shock. E. E. Noble. Read before the Ohio Elec. Lgt. Assn. States some facts learned from experimental investigations, and urges promptness in applying restoratives, giving directions. 2500 w. Cent Sta—Oct., 1905. No. 72436.

Exposition.

Electrotechnics at the Liége Exposition (Die Elektrotechnik auf der Weltausstellung in Lüttich). Dr. M. Corsepius. A general description of the exhibits, with details of lighting devices and transformers. 3500 w. Elektrotech Zeitschr—Oct. 12, 1905. No. 72761 B.

Lightning.

Observations on the Duration of Lightning Flashes (Beobachtungen über die Leuchtdauer der Blitze). K. E. F. Schmidt. A comparison of the observation of various physicists, showing the time to be less than 1 : 30,000 part of a second. 1200 w. Elektrotech Zeitschr—Sept. 28, 1905. No. 72757 B.

INDUSTRIAL ECONOMY

Accounting.

An Accounting System for Mining Supplies. W. M. Jeffery. Read before the Lake Superior Min. Inst. Describes a system that the writer considers the most satisfactory of the various systems under his notice. 4500 w. Ir Age—Oct. 26, 1905. No. 72802.

Charges.

The Financial End of Industrial Engineering. A. E. Dixon. Describes a method for arriving at the fixed charges on an engineering investment, applicable to all investments. 3300 w. Ir Age—Oct. 5, 1905. No. 72387.

Cost-Keeping.

Cost-Keeping for the Foundry. R. W. McDowell. Read before the A. F. A. Convention. Outlines a general system showing the main features of foundry cost accounting. 1400 w. Foundry—Oct., 1905. No. 72632.

Education.

Technical Education for Cincinnati. Herman Schneider. Also editorial. Address before the Cin. Soc. of Mech.

Engrs. An interesting discussion of the qualifications an engineer should possess and suggestions for the development of such engineers. 3000 w. Am Mach—Vol. 28, No. 42. No. 72582.

Technical Reading and Formulas. C. F. Blake. General remarks on self-education. 1700 w. Mach, N. Y.—Oct., 1905. Serial. 1st part. No. 72377 C.

The College Education of the Engineer. William Kent. Presidential address before the Technology Club, Syracuse, N. Y. Outlines the course of most engineering colleges, discussing the results, and giving opinions of prominent educators and critics. 4700 w. Eng News—Oct. 19, 1905. No. 72590.

The Education of Mining Engineers. J. B. Porter. Abstract of a lecture at Kimberley. Discusses the extent to which practical and technical training should enter into an engineering education, outlining a course recommended. 3000 w. Engng—Oct. 13, 1905. No. 72689 A.

Exposition.

The Exposition at Milan in 1906 (Esposizione di Milano 1906). A preliminary account of the buildings and general arrangement of the exposition to be held at Milan in 1906 to celebrate the opening of the Simplon tunnel. 3000 w. Monitore Tecnico—Sept. 10, 1905. No. 72778 D.

Factory Sites.

Kettering. Description and information concerning the advantages of this English town for manufacturing works. Editorial. 6500 w. Engng—Sept. 22, 1905. No. 72312 A.

Great Britain.

Great Britain's Iron Industry. T. Good. Discusses the production, imports, exports, &c., from a British point of view. 3000 w. Cassier's Mag—Nov., 1905. No. 72989 B.

Japan.

Engineering Science in Japan. Robert H. Smith. Reviews some of the interesting papers recently presented to the Society of Mechanical Engineers, Tôkyo, showing the remarkable progress in this field. 3300 w. Engr, Lond—Sept. 22, 1905. No. 72321 A.

Labor.

An Unique Trade Union. A résumé of the plan of organization instituted by E. J. Smith, and in operation in Birmingham, England. 2500 w. Am Mach—Vol. 28, No. 44. No. 72950.

Comfortable Homes in Europe. Illustrations and information concerning the several types of houses and villages constructed for the comfort of those employed in the Krupp works. Comparison is made with the homes of American and British workmen. 4000 w. U S Cons Repts—Sept., 1905. No. 72900 D.

Relations Between Employer and Employed. Francis L. Robbins. Address before the Merchants' and Manufacturers' Assn. An explanation of methods of the Pittsburg Coal Co., which enables their employees to share in the profits. 2000 w. Marine Rev—Oct. 26, 1905. No. 72845.

The Pennsylvania Anthracite Law. R. W. Raymond. Quotes this law, showing that its purpose is to put the anthracite operators at the mercy of the labor unions, and suggests measures that would remove the objectionable features. 1800 w. Eng & Min Jour—Oct. 7, 1905. No. 72433.

The Relations between the Employer and Employed (Verhältnis swischen dem Arbeitgeber und dem Arbeiter). R. Krause. An examination of labor conditions in Germany, discussing especially welfare work and the maintenance of friendly relations between employer and men. 2000 w. Stahl u Eisen—Oct. 1, 1905. No. 72725 D.

Welfare Work. Information of what is being accomplished in this work, taken from statements made by H. H. Vreeland, before the New England Cotton Mfrs. Assn. 1700 w. Eng Rec—Sept. 30, 1905. No. 72364.

Ownership.

Governmental vs. Private Ownership of Public Utilities. Reviews the history of the State of Illinois, which records repeated failures wherever and whenever governmental ownership has been tried. 4000 w. R R Gaz—Vol. XXXIX, No. 14. No. 72405.

Shop Methods.

Manufacturing Methods. C. L. Goodrich. A detailed description of a system of preparing, in advance of the machine work, detail contract slips to assist in keeping workmen constantly employed on the class of work in which they are most efficient. 1200 w. Ir Age—Oct. 26, 1905. No. 72801.

Shop System for Electrical Contractors. Louis J. Auerbacher. Describes a system suitable for a concern doing a general contracting and jobbing business and employing from 15 men upwards. 2300 w. Am Elect'n—Oct., 1905. No. 72384.

Strike.

Recent Strike and Lock-Out in Berlin. H. S. Meyer. A review of the causes of this strike and lock-out of about 40,000 workmen. 900 w. Elect'n, Lond—Oct. 20, 1905. No. 72871 A.

MARINE AND NAVAL ENGINEERING

Boilers.

See Mechanical Engng., Steam Engng.

Car Ferry.

East Ivory Car Ferry of the Missouri Pacific. Illustrated description of a car ferry crossing the Mississippi River about six miles below the Eads Bridge, used for the transfer of freight cars. 1200 w. R R Gaz—Vol. XXXIX, No. 15. No. 72511.

Destroyer.

The Swedish Torpedo-Boat Destroyer "Magne." Illustration, with brief notes comparing with an earlier vessel for the Swedish Government. 350 w. Engng—Sept. 29, 1905. No. 72476 A.

Floating Dock.

The Self-Docking Steel Floating Dry-Dock Dewey. Illustrated detailed description of this large dry-dock built for service in the Philippine Islands. 2800 w. Marine Engng—Oct., 1905. No. 72334 C.

Gas Propulsion.

See Mechanical Engineering, Combustion Motors.

Gliding Boats.

Gliding Boats—The Navigation of the Future. Prof. Daniel Bellet. Gives an illustrated description of Count de Lambert's boat, explaining its principle, and mentioning some other attempts to glide over the water. 1600 w. Sci Am—Oct. 7, 1905. No. 72446.

Ice Yacht.

Improved Ice Yacht Construction. H. Percy Ashley. Describes what is considered the most satisfactory construction. Hollow back bones and 250-sq. ft. sail area. Ills. 1000 w. Sci Am Sup—Oct. 27, 1905. No. 72818.

Jet Propulsion.

A Jet-Propelled Boat. Brief description of the jet propeller invented by Mr. Rankin Kennedy, with diagram. 900 w. Prac Engr—Sept. 29, 1905. No. 72455 A.

Lake Vessels.

Modern Lake Cargo Carriers. Illustration, and description of the Sylvania, one of this season's new boats. 1700 w. Naut Gaz—Oct. 19, 1905. No. 72633.

Lifeboat.

The Twin-Screw Steam Lifeboat "Molesey." Brief illustrated description of the fastest steam lifeboat yet built, and the only one fitted with twin screws. 350 w. Engng—Sept. 22, 1905. No. 72315 A.

Naval Engineers.

The Engineering Personnel of the United States Navy. William Ledyard Cathcart. A critical discussion of the disaster on the U. S. Gunboat "Bennington," and the effect of the Personnel Act upon the efficiency of the engineering service in the navy. 2500 w. Cassier's Mag—Oct., 1905. No. 72626 B.

The Naval Personnel Act and Its Results. J. Snowden Bell. Gives the provisions of the act, and the conditions leading up to it, discussing its purpose, advantages, &c. 6000 w. Am Mach—Vol. 28, No. 42. No. 72579.

Ore Carrying.

The "Elbert H. Gary"—The Greatest of Ore-Carrying Steamers. W. Frank M'Clure. Illustrates and describes one of the four mammoth cargo steamers recently built for the Great Lakes. 700 w. Sci Am—Oct. 14, 1905. No. 72501.

Philippines.

Shipping of the Philippine Islands. H. B. M'Coy. A discussion of the present shipping conditions and the possibilities. 2200 w. Marine Rev—Sept. 28, 1905. No. 72333.

Repairs.

Interesting Repair Work on a German Steamship. Dr. Alfred Gradenwitz. Illustrates and describes repair work on the alumina thermic process on the sternpost of the "Frederick der Grosse." 600 w. Sci Am—Oct. 21, 1905. No. 72592.

Rudders.

Notes on the Calculation of Size of Rudder Stocks. J. W. Clary. Explains the theory of these calculations, giving the results of tests from ships in service, and deriving formulae which may be quickly applied. 4000 w. Marine Engng—Oct., 1905. No. 72335 C.

Shipbuilding.

The Development of the German Shipbuilding Industry (Die Entwickelung der Deutschen Schiffbau Industrie). F. Stellter. A review of the growth of the industry since 1873, with tables and diagrams. Serial. Part 1. 3000 w. Schiffbau—Oct. 11, 1905. No. 72769 D.

Signaling.

Cunard Line and Submarine Signaling. Brief illustrated description of the system devised by the Submarine Signal Co. of Boston, for signaling through the water, and lately tested on the Cunard steamer "Lucania." 600 w. Marine Rev—Oct. 5, 1905. No. 72424.

J. B. Millet's Submarine Signaling System (J. B. Millet's Unterwasser Signaleinrichtungen). Th. Karrass. Describing the successful application of the microphone to the reception of distant bell signals under water. 2000 w. Elektrotech Zeitschr—Sept. 21, 1905. No. 72753 B.

Some Recent Developments in Submarine Signalling. Alfred Gradenwitz. Illustrates and describes the invention of Arthur J. Mundy for sending sound through the water, and some of its applications. 2000 w. Elec Rev, Lond—Sept. 29, 1905. No. 72465 A.

Steamships.

The New Trans-Atlantic Steamship Amerika. Illustrates this new ocean passenger steamship of the Hamburg-American line, describing its novel features. 1400 w. Naut Gaz—Oct. 26, 1905. No. 72846.

The Passenger and Freight Screw-Steamer Kong Haakon. Dr. Alfred Gradenwitz. Illustrates and describes a screw steamer built in Germany, for a Norway company, and is intended to convey passengers and mail between various coast stations. 1200 w. Marine Engng—Oct., 1905. No. 72336 C.

Iron and Steel Hull Steam Vessels of the United States. J. H. Morrison. Reviews the history of iron and steel in hull construction. 4200 w. Sci Am Sup—Oct. 21, 1905. Serial. 1st part. No. 72597.

Steering Gear.

The Electric Steering Gear of the Turbine Steamer "Manxman." Illustrated description of the design and principle of the electrical equipment. The installation is a combination of steam and electric power, either being used as desired, or the vessel may be steered by hand. 1400 w. Sci Am Sup—Oct. 7, 1905. No. 72449.

Submarine.

The First Submarine Boat Built in the Netherlands (De Eerste in Nederland Gebouwde Onderzeesche Torpedo-boote). Illustrated description of a boat built at the Government works on the Schelde from plans of the American Electric Boat Company. 3000 w. De Ingenieur—Sept. 16, 1905. No. 72780 D.

Tow Barge.

Evolution of the Tow Barge. John R. Spears. Reviews the history of the use of the tug and the tow barge, and the future outlook for such transportation. 2000 w. Sci Am—Oct. 14, 1905. No. 72500.

Warships.

The Damaged Russian Warships at Port Arthur. Gives a detailed report of the damage, with comments. 3000 w. Engng—Oct. 20, 1905. No. 72881 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Argyll.

The 1905 Argyll Cars. Information concerning these vehicles and their manufacture. Ills. 2300 w. Auto Jour—Oct. 14, 1905. Serial. 1st part. No. 72667 A.

Clutches.

Some New Expanding Clutches. Brief illustrated descriptions of the Dombret clutch, the Herisson clutch, the Gillet-Forest, and the Julien clutch. 2000 w. Mech Engr—Oct. 7, 1905. No. 72537 A.

Commercial Vehicles.

Industrial Automobiles. A. Frederick Collins. Illustrates and describes some interesting English vehicles of this class. 2000 w. Sci Am Sup—Oct. 14, 1905. No. 72502.

Gears.

The Mitchell Epicyclic Gear. Diagrams and description showing the design and method of this gear. 1200 w. Autocar—Oct. 14, 1905. No. 72670 A.

Ignition.

Magneto Ignition. An illustrated series of articles explaining low- and high-tension magneto ignition. 3500 w. Autocar—Oct. 14, 1905. Serial. 1st part. No. 72669 A.

Mercedes.

A 1906 Mercedes Car—The New 70-H. P. Model. Begins an illustrated description of this new model, and the new features introduced. 2000 w. Auto Jour—Sept. 30, 1905. Serial. 1st part. No. 72451 A.

Motor Vehicles.

The Agricultural Application of the Gasoline Automobile. Notes various applications recently made in England for agricultural purposes, illustrating the Noel motor used as a thresher and at work in a field. 900 w. Sci Am Sup—Oct. 21, 1905. No. 72596.

Omnibus.

40-H. P. Gardner-Serpollet Motor-Omnibus. Illustrates and describes a vehicle carrying thirty passengers which is to be put on trial in Paris. 1200 w. Engng—Oct. 20, 1905. No. 72882 A.

Pierce.

Pierce 1906 Model Touring Cars. Illustrates and describes these cars. A feature is the liberal use of ball bearings. 1700 w. Automobile—Oct. 26, 1905. No. 72821.

Punctures.

Repairing a Puncture—A Modern Method. Illustrates and describes details in the process of effecting a vulcanized repair to an inner tube. 1100 w. Auto Jour—Sept. 23, 1905. Serial. 1st part. No. 72306 A.

Racing.

France Wins the Vanderbilt Cup. A collection of illustrated articles describing the race and the performance of the cars, and giving information of interest. 24000 w. Automobile—Oct. 19, 1905. No. 72601.

The Vanderbilt Cup Elimination Race. Illustrates eight of the ten machines which competed, giving brief descriptions and information of interest. 3500 w. Sci Am—Oct. 7, 1905. No. 72445.

The Winning Cars in the Tourist Trophy Race. A description of the winning Arrol-Johnston car, and the second and third cars of this race on the Isle of Man. Ills. 2200 w. Sci Am Sup—Oct. 21, 1905. No. 72598.

Regent.

The 18-H. P. Regent Car. Begins an illustrated detailed description of a moderate priced car. 800 w. Auto Jour—Oct. 7, 1902. Serial. Part I. No. 72534 A.

Second-Hand Cars.

The Examination of Second-Hand Cars. Gives some experiences of an expert examiner. 2000 w. Autocar—Sept. 30, 1905. Serial. 1st part. No. 72453 A.

Spring Wheel.

The Empire Spring Wheel. The present number explains the principle of the wheel. Ills. 1300 w. Auto Jour—Oct. 7, 1905. Serial. 1st part. No. 72535 A.

Steam.

An 18-H. P. White Steam Car—The 1906 Model. Illustrates and describes this new model, dealing with the novel features which have been embodied. 1700 w. Auto Jour—Sept. 30, 1905. No. 72452 A.

Tourist Trophy.

The Tourist Trophy Race Question. Gives a summary of the articles this paper has published relating to the race, and gives a report of the engine tests made. 2000 w. Auto Jour—Oct. 14, 1905. Serial. 1st part. No. 72668 A.

Vibration.

The Vibration of Automobile Motors. (Die Erschütterungen bei Automobilmotoren). Th. Lembeck. An examination of the inertia forces acting to produce vibration, and a discussion of the disposition of cylinder action to minimize vibratory action. 4500 w. Zeitschr d Mitteleurop Motorwagen Ver—Sept. 30, 1905. No. 72777 D.

COMBUSTION MOTORS.

Diesel.

Trials of a 500 B. H. P. Diesel Oil Engine. Michael Longridge. Describes trials and gives results in tables and diagrams. 1500 w. Mech Engr—Oct. 14, 1905. Serial. 1st part. No. 72674 A.

Gas Engines.

Design, Construction and Application of Large Gas Engines in Europe. Franz Erich Junze. The first of a series of articles dealing with types of engines which have been built and shown results. Considers the two-cycle problem. 3300 w. Power—Nov., 1905. Serial. 1st part. No. 72863 C.

Notes on the Design of Large Gas Engines with Special Reference to Railway Work. Arthur West. Read before the Am. Ry., Mech. & Elec. Assn. Discusses important considerations in the design of large gas engines, and some of the differences in European and American designs. Ills. 2000 w. St Ry Jour—Sept. 30, 1905. No. 72355 C.

The Strang Gas Engine. Illustrates and describes a four-cycle double acting gas engine in which a portion of the exploded charge is mingled in the mixing chamber with the new charge, and returned to the engine. The object is economy. 1200 w. Ir Age—Oct. 12, 1905. No. 72490.

Gasoline Engine.

The Excelsior Reversing Gasoline Engine. Illustrates and describes a two-cycle engine having original features, especially the mechanism for reversing without the use of intermediate gearing. 1500 w. Ir Age—Oct. 26, 1905. No. 72800.

Gas Plant.

Pumping Plant for Sprinkler Supply (Usine Elévatoire pour l'Arrosage). Describing suction producer gas pumping plant for raising water for sprinkling the Tremblay race course. 1500 w. 1 plate. Génie Civil—Oct. 7, 1905. No. 72711 D.

Ignition.

Timing the Ignition in Internal Combustion Engines. Shows the importance of correct timing in regard to economy and power developed. 900 w. Prac Engr—Sept. 22, 1905. No. 72307 A.

Marine Propulsion.

The Application of Combustion Motors to War Ships (Verwendbarkeit von Verbrennungsmotoren zur Fortbewegung Moderner Kreigsschiffe). Lieut. Philippow. A translation from the Russian, showing the practicability and advantages of combustion motors for marine service, with special reference to the Diesel motor. Serial. Part I. 3500 w. Schiffbau—Oct. 11, 1905. No. 72770 D.

Producer Gas.

Lignite Producer-Gas Plants. Dr. Alfred Gradenwitz. Illustrated description of a plant constructed by the Deutz Gas Motor Works, where the tars are decomposed in the producer. 1600 w. Sci Am Sup—Oct. 14, 1905. No. 72506.

HEATING AND COOLING.

Air Pipes.

Air Pipes, Sizes Required for Low Velocities. Considers the pressures required under varying conditions, methods of designing systems of piping, giving table, and examples illustrating its use. 3000 w. Heat & Vent Mag—Oct., 1905. No. 72612.

Armory.

Heating System of the Squadron C Armory, Brooklyn, N. Y. J. Byers Holbrook. Describes the building, which has a large riding hall, as well as the usual administration section and usual armory conveniences. The heating is on the two-pipe, up-feed, low pressure, direct radiation system. 1400 w. Eng Rec—Oct. 14, 1905. No. 72571.

Gas Heating.

Gas Heating Plant. Ernest A. Dowson. Abstract of a paper read before the Birmingham Assn. of Mech. Engrs. Illustrates and describes some applications of gaseous fuel to heating, discussing methods. 1800 w. Ir & Coal Trds Rev—Oct. 6, 1905. No. 72544 A.

Heating Plant.

Steam Tube Heater for Hot Water Heating Plant. A problem requiring the calculations for the size of a heater for warming the water of a hot water heating plant by means of steam, with the method of solving it. 2500 w. Met Work—Oct. 7, 1905. No. 72411.

Hot Blast.

Hot Blast Heating and Ventilation. W. G. Bissell. Gives results of experiments on hot blast apparatus. 1000 w. Iowa Engr—March, 1905. No. 72834 C.

Hot Water.

Hot Water Heating and House Drainage in a Residence in Ellenville, N. Y. Floor plans and sectional elevation, with description of heating and plumbing systems. 2500 w. Met Work—Oct. 7, 1905. No. 72410.

Hot-Water Heating by Single-Pipe System with Secondary Circulation. (Warmwasserheizung, Einrohrsystem mit Sekundärer Zirkulation). O. Krell. A single large main is used, the radiators being placed in shunt circuits. The system is worked out in detail. Serial. Part I. 9000 w. Gesundheits-Ingenieure—Sept. 20, 1905. No. 72771 D.

Overhead versus Underfeed in Hot Water Heating. Konrad Meier. Discusses five examples intended to represent different conditions occuring in practice. Diagrams. 1800 w. Heat & Vent Mag—Oct., 1905. No. 72611.

The Principles of Hot Water Circulation. F. C. Cook. The systems in common use for heating and distributing hot water in an ordinary dwelling-house are discussed, with sketches of the appliances used. 1400 w. Plumb & Dec—Oct. 2, 1905. No. 72533 A.

Refrigeration.

Mechanical Refrigeration. W. W. Edwards. Introduction, explaining the principles of refrigeration, and an illustrated description of the Allen dense air machine and its operation is given in the present number. 2500 w. Engr, U S A —Oct. 2, 1905. Serial. 1st part. No. 72344 C.

The Production of Very Low Temperatures. (Production des Très Basses Températures). A. Lafay. A review of the methods employed in the liquefaction of air and of hydrogen, with illustrations of the apparatus. Serial. Part I. 2500 w. Génie Civil—Sept. 23, 1905. No. 72708 D.

Residence.

Heating and Ventilating a City Residence. Describes a type of indirect heating installed in a residence in New York City. Ills. 1400 w. Heat & Vent Mag—Oct., 1905. No. 72613.

HYDRAULICS.

Air Lift.

The Theory of the Air Lift. An explanation of the theory of operation of this apparatus for lifting water from wells. 1100 w. Compressed Air—Oct., 1905. No. 72827.

Centrifugal Pumps.

Results of Tests of a Forced Vortex Centrifugal Pump. Prof. A. Inokuty. Abstract from the Jour. of the College of Engng., Tokio, Japan. Gives results of tests made of a 7-in. forced vortex centrifugal pump. 700 w. Ills. Prac Engr—Sept. 29, 1905. No. 72454 A.

Turbine Power Station and Centrifugal Pumping Plant at the Holland Mine at

Wattenscheid (Dampfturbinen-Zentrale und Zentrifugal-Wasserhaltung auf Zeche Holland, Schacht I, II, bei Wattenscheid). H. Weitzenmiller. A Rateau steam turbine is directly connected to the dynamo, and the pumping is done by multiple centrifugal pumps driven by electric motors. 2500 w. Glükauf—Sept. 16, 1905. No. 72735 D.

Hydraulic Presses.

Cartridge Case Heading and Indenting Press. Illustrates and describes a hydraulic press for heading and indenting the cartridge cases of quick-firing ammunition. 900 w. Engng—Oct. 6, 1905. No. 72546 A.

Hydraulic Pressing, Stamping and Forging Machinery. F. W. Steele. Read before the Liverpool Engng. Soc. Discusses the designing and its importance, especially of the valves and piping, the velocity of the water through pipes and valves, etc., in this number. 2200 w. Mech ngr—Sept. 30, 1905. Serial. 1st part. No. 72459 A.

Pelton Wheel.

Pelton Wheel with Adjustable Nozzle for the Glyn Slate Company. Illustrated description of a Pelton wheel fitted with a new pattern of variable-discharge nozzle. 600 w. Engng—Oct. 13, 1905. No. 72688 A.

Pumping Engines.

Pumping Engines of the Budapest Water-Works. Illustrates and describes the fly-wheel engines installed to meet the great differences in the consumption of water occurring several times a day. 2200 w. Engr, Lond—Sept. 22, 1905. No. 72322 A.

Rams.

Hydraulic Rams and Pumps. Henry H. Clay. Their construction and uses, with sketches showing their working parts, and descriptive rules for finding the sizes for raising given quantities of water. 1700 w. Plumb & Dec—Oct. 2, 1905. No. 72532 A.

"Sea Mills."

The "Sea Mills" of Cephalonia. William P. Mason. Brief description of mills equipped with undershot wheels which are driven by sea-water flowing landward from the coast. Ills. 300 w. Eng News —Oct. 5, 1905. No. 72403.

Stream Power.

Power Capacity of a Running Stream Without Storage. Reviews Prof. Raymond's analysis of the conditions, as given in a paper before the Iowa Engng. Soc. 1200 w. Eng Rec—Sept. 30, 1905. No. 72360.

Turbines.

The Theory and Computations for Turbines and Centrifugal Pumps (Theorie und Berechnung der Vollturbinen und Kreiselpumpen). H. Lorenz. A mathematical discussion of the curves of turbines of the Francis type, deriving formulas also applicable to centrifugal pumps. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 14, 1905. No. 72732 D.

MACHINE WORKS AND FOUNDRIES.

Air Furnaces.

Types of Air Furnaces. L. G. Blunt. Brief illustrated descriptions of the three principal types in use in the United States, with remarks on the difference in fuel consumption. 600 w. Foundry—Oct., 1905. No. 72628.

Castings.

Gating Malleable Castings. Jean P. Fermal. Information on methods of gating that have given successful castings. 1800 w. Foundry—Oct., 1905. No. 72631.

Notes on Bronze Castings. An illustrated article pointing out the importance of considering thermal conditions, and the suitability of certain alloys for certain classes of work. 1700 w. Ir & Coal Trds Rev—Oct. 13, 1905. No. 72693 A.

Steel Castings and the Constitution of Steel. Percy Longmuir. On the effect of carbon, manganese, silicon, sulphur, and phosphorus. Ills. 1500 w. Foundry—Oct., 1905. No. 72630.

The Preparation of Molds for Steel Castings. Arthur Simonson. Read before the Phila. Found. Foremen's Assn. Discusses molding materials, mixing, the mechanical properties of the mold, core making, &c. 2700 w. Ir Age—Oct. 19, 1905. No. 72574.

Chips.

Is the Constitution of Chips from High-Speed Steel the Same as from the Older Cutting Tools? (Sind die Schnelldrehspäne ebenso Aufgebaut wie die mit den Alten Messern Genommenen?) Max Kurrein. With microphotographs and results of tests, showing the nature of the cuttings to be the same in both cases. 3500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 16, 1905. No. 72748 D.

Cores.

Core Practice and Sands Used for Cores in Various Parts of the Country. R. H. Palmer. Describes sands used in various parts of the United States, the construction of cores, and discusses core compounds. 1800 w. Am Mach—Vol. 28, No. 40. No. 72395.

Cost Keeping.

See Industrial Economy.

Crane Drums.

The Construction of Crane Drums. Joseph Horner. Illustrations and discussion of plain drums, grooved drums, &c., and their manufacture. 1600 w. Am Mach—Vol. 28, No. 40. No. 72396.

Crank-Press.

A Machine-Shop Crank-Press. Illustrates and describes a machine re-invented and re-designed by William A. Box. 600 w. Am Mach—Vol. 28, No. 42. No. 72578.

Cutting.

The Cutting Capacity of Power Presses. E. W. Zeh. Treats only power presses driven direct by the flywheel without the aid of gearing, in the present article, developing formulas. 1400 w. Am Mach —Vol. 28, No. 41. No. 72495.

Drilling Machine.

High-Speed Radial Drilling and Tapping Machines. Illustrates and describes machines designed to meet the requirements as to speed, power, and stiffness called for in the use of modern high-speed tool steel. 1000 w. Engng—Sept. 29, 1905. No. 72474 A.

Floors.

Machine Shop Floors. From *Woodcraft.* Gives the ideas of a number of prominent engineers on the wearing quality of shop floors. 2500 w. Ir Trd Rev —Oct. 26, 1905. No. 72698.

Foundry.

A Large Modern Iron Foundry. Samuel Groves. A brief description of the plant at Trafford Park, England, of the British-Westinghouse Electric & Manufacturing Co. Ills. 1800 w. Can Engr —Oct., 1905. No. 72492.

Foundry Department of the Port Huron Engine and Thresher Co., Port Huron, Mich. Illustrated detailed descriptions of the three foundry plants and their work. 2200 w. Foundry—Oct., 1905. No. 72627.

Gages.

A Set of Accurate Test and Inspection Gages for Small Duplicate Work. Joseph V. Woodworth. Illustrates and describes a set of four tests and inspection gages for verifying measurements of small, accurately machined steel parts. 1400 w. Mach, N Y—Oct., 1905. No. 72379 C.

Gear Cutting.

Cutting Spiral Gears. E. H. Fish. Gives an explanation of a method of figuring these gears, which involves a minimum amount of mathematics. 2500 w. Mach, N Y—Oct., 1905. No. 72376 C.

Hack-Saws.

Recently Designed English Power Hack-Saws. James Vose. Illustrated descriptions of machines for stock up to five-inch diameter, and for stock up to ten-inch diameter. 800 w. Am Mach—Vol. 28, No. 42. No. 72580.

Lathes.

Lathe Design and Practice. E. H. Fish. The present number discusses the cause of chattering, the main spindle bearing, the carriage, and the carriage ways. Ills. 2500 w. Am Mach—Vol. 28, No. 41. Serial. 1st part. No. 72494.

The Ridgway Heavy Driving Wheel Lathe. Illustrated description of a 90-in. heavy driving wheel lathe, with a report of tests of its efficiency. 1800 w. Ir Age —Oct. 26, 1905. No. 72699.

Mechanical Plant.

Plant of the Port Huron Engine & Thresher Co., Port Huron, Mich. Illustrated detailed description of a plant especially noted for the manufacture of high class traction engines. 3000 w. Ir Trd Rev—Oct. 5, 1905. No. 72391.

Moulding.

Molding (in One Piece) a 15-Foot Fly-Wheel in Dry Sand Cores. S. B. Ryder. Illustrates and describes the methods used. 800 w. Am Mach—Vol. 28, No. 42. No. 72583.

Sheave Wheel Molding. R. Davis. Considers the webbed wheel with plain groove, the spoke wheel with plain groove, and the wheel with toothed groove for chain, explaining how each should be prepared for molding. Ills. 2000 w. Am Mach—Vol. 28, No. 40. No. 72398.

Patterns.

The Foundryman's Patternmaker. Paul R. Ramp. Showing the importance of having the foundry foreman competent to determine the proper method of molding and of having the pattern department under his control. Ills. 1200 w. Foundry—Oct., 1905. No. 72629.

Pipe.

The History and Manufacture of Drawn Gas Pipe (Geschichte und Fabrikation Gezogener Gasröhre). Anton Bousse. A review of the earlier processes for making lap-welded pipe, and a description of the machinery and methods of manufacturing drawn tubing. Serial. Part I. 3500 w. Stahl u Eisen—Oct. 1, 1905. No. 72721.

Planing Machines.

Turbine Planing Machine. Illustrated detailed description of a pit-type planing machine for turbine construction. 500 w. Engr, Lond—Oct. 13, 1905. No. 72692 A.

New Automatic Reversing Gear for Electrically-Driven Planers. J. William Chubb. Illustrated description of a system devised by Vickers, Sons and Maxim, Ltd., which consists of a variable-speed motor combined with special switches mounted on the planer and worked from the driving gear. 900 w. Am Mach—Vol. 28, No. 40. No. 72397.

Riveting.

Notes on Workmanship in Riveting. A. J. Himes. A discussion of points in riveting and the testing of rivets. 1600 w. Eng News—Oct. 19, 1905. No. 72589.

Shears.

Improved Electric Block Shears (Neue Elektrisch Betriebene Blockscheren). A. Schwarze. Illustrating and describing shears for cutting hot billets and blocks of steel, arranged for electric driving. Serial. Part I. 3000 w. 1 plate. Stahl u Eisen—Oct. 15, 1905. No. 72729 D.

Shop Methods.

See Industrial Economy.

Shops.

Messrs. Richardsons, Westgarth, and Co's Steam-Turbine Works, Hartlepool. Illustrates and describes a new department recently completed at the Hartlepool Works, and some of the steam-turbines manufactured. 3500 w. Engng—Oct. 13, 1905. No. 72684 A.

The Henry R. Worthington Hydraulic Works. Illustrated detailed description of the new plant at Harrison, N. J. 5000 w. Ir Age—Oct. 12, 1905. No. 72489.

The New Shops of the Watson-Stillman Co. Illustrates and describes this new plant at Aldene, N. J., used for the manufacture of hydraulic machinery. 3000 w. Eng Rec—Oct. 14, 1905. No. 72568.

Speed Control.

Electrical vs. Mechanical Speed Control. Notes the most common mechanical methods used, and the methods used for electrical control, comparing the working, cost, advantages, &c. 4800 w. Engr, U S A—Oct. 16, 1905. No. 72564 C.

Springs.

The Modification of Spring Action by Toggle Joints. E. H. Fish. Illustrated description of a combined spring and toggle joint mechanism. 1000 w. Am Mach—Vol. 28, No. 43. No. 72822.

Symboling.

A Symboling System for Machine Parts. W. Bancroft. Explains a method devised by the Monotype Company to designate the parts of its type-casting and composing machine. This machine contains 2,028 parts. 2500 w. Am Mach—Vol. 28, No. 42. No. 72581.

Tapping Machine.

A Three-Spindle Tapping Machine. John Tangye. Elevation and plan, with description. 2200 w. Prac Engr—Oct. 20, 1905. No. 72867 A.

Waste.

Exhaust Pipe System for Removing Waste Material. M. L. Kaiser. An illustrated series of articles on the details of exhaust pipe work in factories, mills, and shops. The present article deals with a shavings exhaust plant for a planing-mill. 1300 w. Met Work—Oct. 21, 1905. Serial. 1st part. No. 72614.

MATERIALS OF CONSTRUCTION.

Alloys.

A Study of Copper-Aluminum Alloys (Etude Théorique et Industrielle des Alliages de Cuivre et d'Aluminum). L. Guillet. With diagrams and microphotographs showing the properties of the various copper-aluminum alloys, indicating those of industrial value. 5000 w. Revue de Métallurgie—Aug., 1905. No. 72784 G.

The Constitution of the Copper-Aluminum Alloys (Constitution des Alliages Cuivre-Aluminium). Lêon Guillet. An examination of the various solid solutions existing in the industrial alloys of copper and aluminum, and a discussion of their properties. 1200 w. Comptes Rendus—September 4, 1905. No. 72717 D.

Corrosion.

A Study of the Corrosion of Condenser Tubes. A. Humboldt Sexton. A critical examination of the behavior of brass tubes in contact with sea water, with regard to the causes and possible prevention of corrosion. 4500 w. Engineering Magazine—Nov., 1905. No. 72790 B.

The Corrosion of Copper by Sea Water (La Corrosion du Cuivre par l'Eau de Mer). A review of the tests made by the German Navy, with discussion of the methods of prevention of corrosion. 2000 w. Génie Civil—Sept. 23, 1905. No. 72710 D.

Lubricants.

Selection of Oils. A. O. Towney. Suggestions for the selection of the right oils. 1000 w. Engr, U S A—Oct. 2, 1905. No. 72347 C.

Packings.

Metallic Packings. R. T. Strohm. States the advantages of metallic packings, and illustrates and describes several forms. 3000 w. Am Elect'n—Oct., 1905. No. 72382.

Rivets.

The Shearing Strength of Rivets. E. S. Fitzsimmons. Read at convention of Mas. Steam Boilermakers. Describes tests made and results. 1200 w. Ir Trd Rev—Oct. 5, 1905. No. 72392.

Special Steels.

Steels Especially Used in Automobile Construction (Aciers Spéciaux Employés en France dans la Construction des Automobiles). Léon Guillet. Discussing especially nickel, chrome, and silicon steels. 3000 w. Génie Civil—Oct. 7, 1905. No. 72712 D.

Steel Used for Motor Car Construction in France. Léon Guillet. Read before the Ir. & Steel Inst. Discusses in detail the chief special steels actually employed in the motor car industry. 4500 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72519 A.

Staybolts.

The Quality and Utility of Solid, Flexible and Hollow Staybolts, in Iron and Copper. John Livingstone. A discussion of this subject giving much information of value, and followed by a short general discussion. 13000 w. Pro N Y R R Club—Sept. 15, 1905. No. 72609.

Steel Rails.

Wear of Steel Rails on Bridges. Thomas Andrews. Read before the Ir. & Steel Inst. Report of investigations made of the fractured portion of a steel rail which had broken in main line service on a bridge, to determine, if possible, some of the causes of the breakage. Ills. 3500 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72520 A.

Test-Pieces.

The Presence of Greenish-Colored Markings in the Fractured Surfaces of Test-Pieces. H. G. Howorth. Read before the Ir. & Steel Inst. Describes markings found in gun-steel test-pieces, the large proportion in which defects have been observed, and discusses their probable cause. 2800 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72513 A.

Tool Steels.

High-Speed Steel in the Factory. O. M. Becker & Walter Brown. The third article gives working directions for making the tools, including hardening and tempering furnaces and details of manipulation. 3500 w. Engineering Magazine —Nov., 1905. No. 72792 B.

MEASUREMENT.

Friction.

The Laws of Sliding Friction (Sur les Lois du Frottement de Glissement). Paul Painlevé. A discussion of some of the ambiguous features in the accepted laws of the friction of rest and of sliding motion. 2000 w. Comptes Rendus—Aug. 21, 1905. No. 72716 D.

The Laws of Sliding Friction (Sur les Lois du Frottement de Glissement). Paul Painlevé. A further examination of the laws of Coulomb, showing their entire inadmissibility in certain cases. 2500 w. Comptes Rendus—Oct. 2, 1905. No. 72718 D.

Hydrometer.

How to Make a Hydrometer. Edward F. Chandler. Remarks concerning specific gravity, and illustrated description of the construction. 1100 w. Sci Am Sup —Oct. 21, 1905. No. 72595.

Inertia.

Moments of Inertia. Shows how they may be deduced by methods which require a merely elementary mathematical knowledge. 3500 w. Mech Engr—Sept. 30, 1905. No. 72457 A.

Refractometer.

An Improved Form of Refractometer. Illustrated description of an instrument, designed by G. F. Herbert Smith, in which the refractive power of a substance is determined by the method of total reflection. 1800 w. Min Jour—Oct. 14, 1905. No. 72671 A.

Strength.

Strength of Sections of Machinery. Frank B. Kleinhans. Presents a table which gives the moment in inch-pounds for various fiber stresses for circular sections, explaining its use. 700 w. Engr, U S A—Oct. 2, 1905. No. 72343 C.

Weighbridge.

The Avery Patent Combination Weighbridge. Illustrated description of a design which is so constructed and arranged that when a car is upon the weighbridge the load can be immediately ascertained upon either the one or the other axle or upon the two combined. 1000 w. Prac Engr—Sept. 29, 1905. No. 72456 A.

POWER AND TRANSMISSION.

Coal-Handling.

A Unique Coal-Handling Plant for an Electric Power Station. Illustrated description of the auxiliary coal storage and handling plant of the Syracuse, N. Y., lighting company. 1000 w. Eng News—Oct. 19, 1905. No. 72584.

Clutch.

A Novel Coil-Clutch Reversing Gear. Illustrates and describes an ingenious reversing gear placed on the English market, which is especially valuable with large machinery. 700 w. Sci Am Sup—Oct. 7, 1905. No. 72448.

Conveyors.

Belt Coal Conveyors. Francis H. Davies. An illustrated article describing early and recent types. 2400 w. Elec Rev, Lond—Oct. 13, 1905. No. 72678 A.

Cranes.

See Civil Engng., Waterways and Harbors.

Elevators.

Test of Electric Passenger Elevators in the Park Row Building, New York City. G. A. Balz, G. I. Brauch, and T. E. Landvoigt. Graduation Thesis. The object of the test was to determine the energy consumption of the electric elevators in kilowatt hours per car mile, and the average number of passengers carried. 4000 w. Stevens Ind—July, 1905. No. 72830 D.

The Hammetschwand Elevator on the Burgenstock (Der Hammetschwand Aufzug am Bürgenstock). An illustrated description of an elevator of 118 metres high, giving access to the cliffs on the bank of the lake of Lucerne. 1500 w. Schweiz Bauzeitung—Oct. 7, 1905. No. 72746 B.

Exhibition.

Prime Movers and Auxiliary Plant at Olympia. E. G. Beaumont. A review of the exhibits of this class shown at the electrical exhibition. 1800 w. Elec Engr, Lond—Sept. 29, 1905. Serial. 1st part. No. 72462 A.

Fans.

Fans. Charles L. Hubbard. Considers the centrifugal fan and the disk fan, explaining their theories, capacity, effect of temperature, &c. Ills. 3500 w. Mach, N Y—Oct. 1905. Serial. 1st part. No. 72373 C.

Gears.

The Worm Gear. John Edgar. A discussion of this form of gearing, referring to Mr. Halsey's article in the *American Machinist.* 1200 w. Mach, N Y—Oct., 1905. No. 72375 C.

Hoisting.

Hoisting Machinery at the Liége Exposition (Les Appareils de Levage à l'Exposition de Liége). L. Ramakers. Illustrations and details of electric traveling cranes exhibited in operation at Liége. 2000 w. 1 plate. Génie Civil—Sept. 23, 1905. No. 72707 D.

Prime Movers.

Prime Movers and Their Accessories in 1904. Editorial review of some features of Mr. Longridge's report for 1904 to the British Engine, Boiler, and Electrical Insurance Company, Ltd. 2000 w. Engng—Oct. 20, 1905. No. 72878 A.

Roller Bearings.

The Friction of Roller Bearings. C. H. Benjamin. Reports a series of experiments in which roller bearings were compared with plain cast-iron bearings and with babbitted bearings under similar conditions. 1000 w. Mach, N Y—Oct., 1905. No. 72374 C.

STEAM ENGINEERING.

Accidents.

Accidents Due to Faulty Piping and Incorrect Methods of Starting and Stopping Engines. Thomas Hall. Illustrated review of accidents due to faulty construction. 2400 w. Power—Nov., 1905. No. 72859 C.

Back Pressure.

Automatic Exhaust Relief Valve. Illustrates and describes the Anderson valve, which is claimed to have overcome all the difficulties met with in valves for maintaining a predetermined back pressure on steam engines. 1000 w. Engr, Lond—Oct. 20, 1905. No. 72889 A.

Boiler Firing.

An Aid to Systematic Firing of Marine Boilers. H. E. Lackey. Brief illustrated description of a device used on the "Galveston" to secure systematic firing. 700 w. Pro U S Nav Inst—Sept., 1905. No. 72599 D.

Boiler House.

Modern Boiler House Equipment. Franz Koester. An illustrated comparative review of modern European and American practice. 3000 w. St Ry Rev—Oct., 1905. No. 72636 C.

Boilers.

A New Type of Marine Fire-Tube Boiler. Illustrated description of the Scialpi boiler, with report of trials, and general information. 2500 w. Engr, Lond—Oct. 6, 1905. No. 72551 A.

Hydrostatic Tests of Locomotive Boilers. George Wagstaff. Discusses whether it is necessary or desirable to give a locomotive boiler the hydrostatic test, and if so, whether it should be greater than the allowed steam pressure. Also general discussion. 3300 w. Pro Cent Ry Club—Sept. 8, 1905. No. 72844 C.

Modification in Boiler Design Required by Liquid Fuel. George W. Melville. Excerpt from a paper presented at Milan. Showing that liquid fuel requires an ample combustion space. 2800 w. Eng & Min Jour—Sept. 30, 1905. No. 72393.

Robert Water-Tube Locomotive Boiler. M. F. Barbier, in *Le Genie Civil.* Illustrated description of a boiler of this type, which for more than a year has been in successful working in France. 1000 w. R R Gaz—Vol. XXXIX, No. 13. No. 72341.

Steam Boilers of the Past and Present. Egbert P. Watson. An historical review showing the evolution of modern types, with especial reference to boilers for marine service. 4500 w. Engineering Magazine—Nov., 1905. No. 72791 B.

Condensing Plant.

Condensing Plants for High Vacuums. The first of an illustrated series of articles describing the arrangement of the condensing apparatus in several kinds of turbines. 1800 w. Mach, N. Y—Oct., 1905. Serial. 1st part. No. 72380 C.

Draught.

Natural and Induced Draught. John W. Cobb. Explains briefly the mode of action of a chimney, and the production of forced draught, comparing their efficiency and things that should influence the choice of draught. 2500 w. Eng & Min Jour—Oct. 14, 1905. No. 72524.

Engines.

A Pacific Coast Engine. Illustrates and describes interesting features of a triple-expansion engine built to drive an alternating-current generator of 3,500 kw. capacity. 1200 w. Am Mach—Vol. 28, No. 41. No. 72493.

Possible Advantages of the Triple-Expansion Engine Over the Compound. E. F. Williams. Explains the merits and advantages of triple-expansion engines. 1800 w. Engr, U S A—Oct. 16, 1905. No. 72562 C.

Proposed Methods for Improving the Efficiency of the Steam Engine (Beschouwingen over de Middelen Aangewend ter Verhooging van het Rendement der Stoommachine). G. Brouwer. Discussing especially the advantages of compounding and the use of highly superheated steam. 4000 w. De Ingenieur—Sept. 30, 1905. No. 72782 D.

The Cockerill Rolling Mill Engine at the Liége Exhibition. Two-page plate and other illustrations, with brief description of this 10,000 h.p. reversing compound three-crank tandem steam-engine. 500 w. Engng—Sept. 22, 1905. No. 72313 A.

Expansion.

Conversion of Heat into Work by Adiabatic Expansion. A. M. Sevin. Gives table for finding the total energy obtained by expanding steam adiabatically, with explanation of its use. 2000 w. Power—Nov., 1905. No. 72860 C.

The Expansion of Wet Steam. Prof. Robert H. Smith. Explains a new law for the calculation of the work done during expansion. It is not exact, but has a very high order of accuracy, and is extremely simple and suited for practical calculation. 3300 w. Engr, Lond—Oct. 20, 1905. No. 72884 A.

Explosions.

Steam-Boiler Disasters (Uufälle aus dem Dampfkesselbetriebe). An abstract from a report of the Dortmund boiler inspection company, with illustrations and description of an explosion involving a collapsed flue. 1500 w. Glúckauf—Oct. 7, 1905. No. 72738 D.

Flange Joints.

Packing Flange Joints. W. H. Wakeman. Suggestions helpful to the inexperienced. Ills. 1500 w. Power—Nov., 1905. No. 72861 C.

Load Diagram.

Load Diagram of a Mill Engine. F. H. Pember. Gives a diagram showing how the data derived from indicator cards, may be so arranged that they will present a graphic record of the all-day variations of load. 2000 w. Power—Nov., 1905. No. 72862 C.

Lubricators.

The Latest Makes of Lubricators, Their Operation and Maintenance. C. B. Conger. Abstract of a paper read before the Trav. Engrs. Assn. Describes changes introduced in late designs. 2000 w. Ry Age—Oct. 6, 1905. No. 72423.

Oil Fuel.

Equipment for Oil Fuel. George W. Melville. Excerpt from a paper presented to the Tenth Navigation Congress at Milan, 1905. Deals with strainers, the separation of water, oil pressure regulators, etc. 1200 w. Eng & Min Jour—Oct. 7, 1905. No. 72429.

Oil-Separators.

Oil-Separators at Shepherd's Bush Power-Station; C. L. Railway. Illustrated description of the improved Baker separators installed at the Central London Railway Co.'s power station. 900 w. Engng—Oct. 20, 1905. No. 72876 A.

Papin.

Papin's Direct-Acting Steam Pump (Papin's Direktwirkende Dampfpumpe). Conrad Matschoss. With a reproduction of Papin's early design of 1707, and a brief discussion of its historical position. 1000 w. Zeitschr d Ver Deutscher Ing—Oct. 14, 1905. No. 72733 D.

Sawmill Refuse.

The Value of Saw-Mill Refuse as a Fuel. O. B. Coldwell. Gives information concerning the lumber industry at Portland, Ore., and its by-products, describing the method of using the mixture of sawdust and cut-fuel as a steam producer, especially as related to the manufacture of electrical energy. 3000 w. Jour of Elec —Oct., 1905. No. 72576 C.

Smoke.

The Smoke Nuisance. R. P. King. Read before the Toledo convention of the League of Am. Munic. Considers the causes and remedies. 2000 w. Munic Jour & Engr—Oct., 1905. No. 72327 C.

Steam Economy.

Figuring the Steam Consumption from

the Indicator Diagram. S. H. Bunnell. Explains the method. 1200 w. Power—Nov., 1905. No. 72865 C.

Suggestions for Steam Economy. William McKay. Read before the Canadian Elec. Assn. Discusses some of the principles upon which economy in the use of steam depends. 2500 w. Sci Am Sup—Oct. 14, 1905. No. 72503.

Steam Lines.

Long Steam Line Construction. G. W. Barrager. Discusses the covering and the construction of the line. The size of pipe, the route and grading of the line, and other matters of importance are considered. Ills. 2500 w. Power--Nov., 1905. No. 72864 C.

Superheating.

Method of Computing the Amount of Superheating of Steam in the Cylinder of a Superheated Steam Engine. Prof. D. S. Jacobus. A detailed explanation of the method used by the writer. 700 w. Stevens Ind—July, 1905. No. 72829 D.

Turbines.

New Steam Turbine Power Plant of the Detroit Edison Company. Illustrated detailed description of this large new central generating plant and its equipment. 5500 w. Eng Rec—Oct. 7, 1905. No. 72482.

Steam Turbines (Ueber Dampfturbinen). Anton Kallus. A general review of the principles involved in the steam turbine, with descriptions of the various types. Two articles, 1 plate, 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 16, 23, 1905. No. 72739 each D.

The Steam Turbines of the Union Machine Works of Essen (Die Dampfturbinen der Maschinenbau-Aktien-Gesellschaft Union in Essen d. d. Ruhr). Fritz Krull. General details of the Union turbine, as exhibited at Liége. 3000 w. Schweiz Bauzeitung—Sept. 30, 1905. No. 72745 B.

Steam Turbines (Stoomturbines). J. de Kuyser. A general description of the principal types now before the public, with illustrations. 5000 w. 2 plates. De Ingenieur—Sept. 30, 1905. No. 72781 D.

Valve-Gears.

The Operation of Valve Gears by Cams (Die Bewegungsverhältnisse von Stuergetrieben mit Unrunden Scheiben). W. Hartmann. A study of the kinematics of cam movements with especial reference to their applications in operating the valves of steam and gas engines. Two articles, 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 30, Oct. 7, 1905. No. 72703 each D.

MISCELLANY.

Aeronautics.

The Dufaux Flying Machine. Illustrated description of a new apparatus able to rise in the air by the force of its propellers alone, driven by a gasoline motor. Recently tested at Paris. 1200 w. Sci Am—Oct. 21, 1905. No. 72591.

Breakdowns.

Breakdowns of Machinery in 1904. Interesting extracts from the report of Michael Longridge, which deals with mishaps in connection with engines, boilers, dynamos and motors. 1500 w. Elec Rev, Lond—Sept. 29, 1905. No. 72466 A.

Hotel Engineering.

The Engineer's Department of a Large Hotel. Storrs Ely Emmons. Gives some idea of the importance of this department and the need of system in its management. 1000 w. Mach, N. Y—Oct., 1905. No. 72378 C.

Projectiles.

The Action of Capped Armor-Piercing Shell. Eugen Kodar v. Thurnwerth. Capt. George Blakely. Translated from the German. Examines the reasons of the increased penetration of capped projectiles, on the basis of tests made with a variety of plates. Ills. 4300 w. Eng News—Oct. 5, 1905. No. 72400.

Woolwashing.

Woolwashing. Begins an illustrated description of apparatus designed for this work. 3000 w. Engr, Lond—Sept. 22, 1905. Serial. 1st part. No. 72319 A.

MINING AND METALLURGY

COAL AND COKE.

Arkansas.

Coal Mining in Arkansas. W. R. Crane. Describes and illustrates the deposits, methods of mining, preparation of the coal, etc. 3300 w. Eng & Min Jour—Oct. 28, 1905. No. 72851.

Briquettes.

The Schorr Briquette Press. Robert Schorr. Brief illustrated description of machine especially adapted for the manufacture of small briquettes for fuel. 600 w. Eng & Min Jour—Oct. 7, 1905. No. 72430.

Explosives.

Regulation of Explosives in Coal Mines. James Tonge. Remarks on the risks in the use of explosives, with a description of the nature of the tests at Woolwich. 3500 w. Ir & Coal Trds Rev—Oct. 13, 1905. No. 72694 A.

Haulage.

Animal Haulage in Coal Mines. Charles E. Bowron. Notes and data in regard to costs, derived from experience at mines in Alabama and Tennessee. 2600 w. Mines & Min—Oct., 1905. No. 72415 C.

The Mahanoy Coal Plane. Illustrates and describes the machinery used, and the method of hauling loaded railroad cars over the mountain from Mahanoy Valley. 1100 w. Mines & Min—Oct., 1905. No. 72414 C.

Illinois.

The Spring Valley Coal Company's Mines. Leo Gluck. An illustrated description of this coal field in Illinois, and the operation of the mines. 3500 w. Min Wld—Oct. 21, 1905. No. 72662.

Lignite.

The Lignite Deposits at Hrastovetz (Der Braunkohlenbergbau von Hrastovetz). Ivan Kavcic. An account of the deposits of brown coal in lower Styria, with data of chemical composition and calorific power. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 14, 1905. No. 72744 D.

Midlands.

The Search for Coal Beneath the Red Rocks of the Midland Counties. Wolcot Gibson. Gives important results obtained from the examination of several borings, with remarks of interest to mining engineers. 1500 w. Col Guard—Sept. 22, 1905. Serial. 1st part. No. 72311 A.

Peat.

Peat: Its Uses and Value. C. C. Schnatterbeck. Describes this product, and states the localities in the United States where deposits are found, describing the Peatkoal plant at New Rochelle, N. Y. Mentions some of its uses. 1200 w. Min Wld—Sept 30, 1905. No. 72330.

Peat Machine.

The Leavitt Peat Machine. Illustrated description of a machine designed to prepare crude peat by condensing for the evaporating treatment. 1500 w. Ir Age—Oct. 19, 1905. No. 72572.

Texas.

The Coal Fields of Texas. Heinrich Ries. Gives the locations of the different deposits, the quality of the coals as shown by analyses, and the production of the state. Ills. 1500 w. Mines & Min—Oct., 1905. No. 72416 C.

COPPER.

Alaska.

Central Copper Region, Alaska. Information from the report of Walter C. Mendenhall concerning this interesting region. 800 w. Min Wld—Sept. 30, 1905. No. 72331.

Mexico.

The La Dicha Mine, Guerrero, Mexico. Illustrated description of these copper mines, one of the most important American enterprises in Mexico. The ores are almost entirely pyritic sulphides, associated with chalcopyrite, and iron pyrite, and a valuable layer of black copper sulphide. 1200 w. Min Wld—Oct. 28, 1905. No. 72898.

Ores.

The Working of the Black Copper Ores at the Oker Works (Die Verarbeitung der Speisen und Speisigen Schwarzkupfer auf der Okerhütte). H. Huhn. A description of the working of the mixed copper-lead ores of the Rammelsberg district, in the Harz. 4000 w. Glückauf—Sept. 16, 1905. No. 72734 D.

Treatment of Copper Ore by the Electric Furnace. M. Vattier. Translated from the French. An account of experiments made in the metallurgy of copper where water power is available, by substituting electricity for coke, coal or charcoal. Describes the operations and methods used. 2200 w. Min & Sci Pr—Sept. 23, 1905. No. 72332.

Smelting.

The Bormettes-Method Lead and Copper Smelting. Alfredo Lotti. Illustrated description of this system, comparing it with other methods. 1600 w. Eng & Min Jour—Sept. 30, 1905. No. 72394.

Victoria.

The Walhalla Copper Mine (V.). William Baragwanath, Jr. Describes the location and deposits, development, etc. 3500 w. Aust Min Stand—Aug. 30, 1905. No. 72371 B.

GOLD AND SILVER.

Alaska.

Gold Mining in Southeastern Alaska (Der Goldbergbau in Südost Alaska). H. Haagen. Illustrating and describing the Alaska-Treadwell plant on Douglas Island. Two articles, 8000 w. Glückauf—Oct. 7, 14, 1905. No. 72737 each D.

Appalachians.

Gold Mining in the Southern Appalachians. Thomas T. Read. General notes concerning this field and its development. Map. 1000 w. Min Rept—Oct. 19, 1905. No. 72660.

Assay.

Notes on the Assay of Gold Bullion. T. Kirke Rose. A brief account of the principal changes in the assay of gold bullion which have been introduced at the Royal Mint, London, during the last three years. 1800 w. Jour Chem, Met & Min Soc of S Africa—Aug., 1905. No. 72675 E.

Australia.

Australian Gold and Gold Mining. John Plummer. Information of interest concerning the production, development, and present condition of the industry. 1000 w. Min Wld—Oct. 14, 1905. No. 72555.

Black Sands.

Investigation of Black Sands by the United States Geological Survey. Gives results from the assaying of 195 specimens for gold and platinum, and an account of field work and concentration experiments. 1400 w. Min Rept—Oct. 5, 1905. No. 72437.

Broken Hill.

Broken Hill Proprietary Co. A review of the 20 years' record of this mine, especially the half-yearly statement for the period ending May 31, 1905. Silver-lead mining. 2200 w. Aust Min Stand—Aug. 23, 1905. No. 72369 B.

Central America.

Darien Gold Mines. An illustrated description of the Espiritu Santo mine and its development under hard conditions. 1500 w. Min & Sci Pr—Sept. 30, 1905. No. 72439.

Comstock Lode.

Structure and Genesis of the Comstock Lode. John A. Reid. (Abstract.) Describes the formation, showing evidence of successive deposition in the Virginia City portion of the lode, and giving information of interest. 2500 w. Min & Sci Pr—Oct. 7, 1905. No. 72559.

Cripple Creek.

Drainage of the Cripple Creek District. An epitome of the recommendations of D. W. Brunton relative to the construction of a drainage tunnel. Map. 500 w. Min Rept—Oct. 19, 1905. No. 72661.

Cyanide Mill.

The Tonopah Milling Co.'s Mill. S. A. Worcester. Outline drawings and description of a mill to be located at Goldfield Junction. 1000 w. Eng & Min Jour—Oct. 14, 1905. No. 72526.

Dredging.

Application of Electric Power to Gold Dredging. J. F. Dostal. Read at meeting of the Colorado Elec. Lgt., Power & Ry. Assn. Describes the object and method of dredging and the schemes for regaining the gold. Also describes the dredgers and the electrical equipment of one of them. 2200 w. Min & Sci Pr—Oct. 7, 1905. No. 72560.

The Career of the Gold Dredge in New South Wales. David K. Blair. Abstract of a paper in *Trans. of the Australasian Min. Engrs.* Gives a brief history of the career of the gold dredge from its introduction, March, 1899, up to the present time. 2200 w. Eng & Min Jour—Oct. 28, 1905. No. 72850.

Egypt.

The Gold Production of Egypt. Reviews what is known of the early history of gold mining in Egypt. Map. 3000 w. Min Jour—Oct. 14, 1905. No. 72672 A.

Fluxing Ores.

A District Which Will Supply Fluxing Ores for the Tonopah (Nev.) Mines. W. J. Stoneham. Information concerning the Lone Mountain Mining district, and the large bodies of fluxing ore found there. 1200 w. Min Wld—Oct. 7, 1905. No. 72438.

Nevada.

Ores of Goldfield, Nevada. J. E. Spurr. Abstract from "Contributions to Economic Geology" for 1904. Considers the geological situation, the nature and origin of the ore deposits, and conditions in the region. 2700 w. Mines & Min—Oct., 1905. No. 72419 C.

Nova Scotia.

In Nova Scotia. T. A. Rickard. Gives a map of the gold region, and information concerning conditions in the mining region in the present article. 1200 w. Min & Sci Pr—Oct. 21, 1905. Serial. 1st part. No. 72890.

South America.

Gold Mining in South America. J. H. Curle. From *The Economist.* Information concerning this industry, the output, the drawbacks and the future development. 1200 w. Min Rept—Oct. 12, 1905. No. 72557.

South Dakota.

Common Sense Mining. W. H. Storms. On the management of low-grade mines, discussing especially the gold mines of South Dakota. 2200 w. Min & Sci Pr—Oct. 21, 1905. No. 72891.

IRON AND STEEL.

Blast Furnaces.

Notes on American Blast-Furnace Practice (Betrachtungen über den Amerikanischen Hochofenbetrieb). Bernhard Osann. A comparison between American and German furnaces and methods. 3500 w. Stahl u Eisen—Oct. 15, 1905. No. 72728 D.

Practical Results in the Operation of the Blast Furnaces of Ekaterinoslav, Russia (Résultats Pratiques de la Marche des Haut Fourneaux d'Ekaterinoslaw). M. Pierronne. Data and results of the action of furnaces of various sizes and forms, with sketches and discussion. 10,000 w. Revue de Métallurgie—Sept., 1904. No. 72785 G.

Carbon.

The Two Forms of Carbon in Iron Temper-Carbon and Graphite (Beitrage zur Kenntuis der Zwei Kohlenstofformen im Eisen, Temperkohle und Graphit). F. Wüst and C. Geiger. A study of the influence of heat treatment upon the combination of carbon in iron. Serial. Part I. 3000 w. Stahl u Eisen—Oct. 1, 1905. No. 72724 D.

Carbon Steels.

The Thermal Transformations of Carbon Steels. John Oliver Arnold and Andrew McWilliam. Read before the Iron & Steel Inst. Gives the composition of the three steels selected for the research work described, the methods, etc. Ills. 8500 w. Engng—Sept. 29, 1905. No. 72477 A.

Electric Smelting.

See Electrical Engineering, Electro-Chemistry.

Furnace Gases.

Blast-Furnace Gases. John Herman, in *Western Chemist and Metallurgist.* Gives analyses made of gases in several places, discussing the fuel and blast. 1200 w. Eng & Min Jour—Oct. 21, 1905. No. 72643.

Cleansing Blast-Furnace Gas. Axel Sahlin. An illustrated article showing the advantages and importance of cleaning the gas, and the methods of cleaning; describing apparatus used. 4500 w. Cassier's Mag—Oct., 1905. No. 72623 B.

The Bian Apparatus for Purifying and Cooling Blast-Furnace Gases (Reinigungs und Kühlapparat für Hochofengase System Bian). Fritz Krull. The gas is passed through disks of wire netting partly immersed in water. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 14, 1905. No. 72743 D.

Handling.

A Manipulator for Steel Bars. Douglas Upton. Read before the Iron and Steel Inst. Illustrates and describes appliances for the mechanical handling of sectional material during the process of manufacture. 700 w. Engng—Sept. 29, 1905. No. 72478 A.

Iron Deposits.

Iron Resources of the World. R. Anspach. Translated from the *Zeit. für angewandte Chemie.* Information from the report of Prof. A. E. Törnebohm to the Swedish Parliament. 2800 w. Eng & Min Jour—Oct. 7, 1905. No. 72432.

Italy.

The Iron Industry of Italy (Die Eisenindustrie Italiens). Carl Brisker. With tabular statements of the output of the various districts and of the exports and imports of iron ore and pig iron. 5000 w. Stahl u Eisen—Oct. 1, 1905. No. 72720 D.

Nickel Steel.

The Reversible and Irreversible Transformations of Nickel Steel. L. Dumas. Abstract of a paper read before the Ir. & Steel Inst. Discusses the remarkable properties of nickel steels which have not undergone the irreversible transformation, and the effects produced by adding nickel to steel. 1500 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72521 A.

Pig-Irons.

Note on the Occurrence of Copper, Cobalt, and Nickel in American Pig-Irons. E. D. Campbell. Read before the Ir. & Steel Inst. Gives analyses of samples, mostly from charcoal or coke blast furnaces in the United States, to determine the extent to which copper, cobalt, and nickel occurs in pig-iron made from ore found in the different districts. 800 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72518 A.

Rolling Mills.

Electric Driving of Reversing Rolling Mills (Der Elektrische Antrieb von Reversierwalzwerken). Karl Ilgner. A discussion of the advantages of electric driving for rolling mills, with data and results of tests upon a number of installations. Two articles, 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 22, 29, 1905. No. 72714 each D.

Electric Driving of Rolling Mills (Elektrischer Antrieb von Walzwerken). A. Bayer. A mathematical examination of the conditions of rolling-mill work, showing the proportions of fly-wheel necessary to overcome the maximum resistance. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 23, 1905. No. 72740 D.

Segregation.

Segregation in Steel Ingots. B. Talbot. Read before the Ir. & Steel Inst. Gives tabulated results obtained from parallel tests made on ingots from the same heat, with and without the addition of a small amount of aluminum to the ingot, discussing the effects. 2800 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72514 A.

Sheffield.

Sheffield Past and Present. An interesting review of the rise, progress, and existing conditions of the steel industry. 10500 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72512 A.

Slags.

Recent Investigations upon Blast-Furnace Slag (Neue Untersuchungen über Hochofenschlacke). Dr. Hermann Passow. Experiments upon the granulation of slag for the manufacture of cement. 1500 w. Stahl u Eisen—Oct. 1, 1905. No. 72723 D.

The Melting Point of Slags and Other Members of the Series SiO_2—Al_2O_3—CaO. Clifford Richardson. Calls attention to the fact that many of the melting points and conclusions drawn from them are erroneous. 1000 w. Ir & Steel Mag—Oct., 1905. No. 72600 D.

Steel.

Overheated Steel. Arthur Windsor Richards, and John Edward Stead. Reviews opinions of investigators of overheated steel, and gives further researches of the writers, emphasizing the fact that poor steel cannot be made into good steel by any kind of heat treatment, but that good steels heated short of incipient disintegration can be completely restored. 4500 w. Engr, Lond—Sept. 29, 1905. No. 72481 A.

Steel Industry.

The German Steel Makers Association and Its Commercial Influence (Der Deutsche Stahlwerks-Berband und Seine Bedeutung für unser Wirtschaftsleben). Oscar Simmersbach. A review of the German steel industry with comparative diagrams and tables, and an examination of the influence of the combination upon the trade. 9000 w. Glasers Annalen—Oct. 1, 1905. No. 72719 D.

Steel Process.

The Chemical Action in the Combined Bessemer-Open-Hearth Process at Witkowitz (Chemische Vorgänge beim Kombinierten Bessemer-Martin Verfahren zu Witkowitz). C. Canaris. Giving the composition of the charges, and the chemical and mechanical properties of the product. 2000 w. Stahl u Eisen—Oct. 1, 1905. No. 72722 D.

The Use of Blast-Furnace Gas for the Reduction of Iron Ore in Modern Open-Hearth Steel Processes (Hochofengase zum Reduzieren von Eisenerz für die Neueren Herdofenstahlprozesse). Oskar Simmersbach. Giving the chemical equations and thermal reactions involved in the reduction of various ores by carbon monoxide. 1200 w. Stahl u Eisen—Oct. 15, 1905. No. 72730 D.

Steels.

The Influence of Nickel and Carbon on Iron. G. B. Waterhouse. Read before the Ir. & Steel Inst. A report of research work, considering a series of steels of constant nickel with varying carbon percentages. 1500 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72516 A.

Vanadium.

The Use of Vanadium in Metallurgy. Léon Guillet. Read before the Ir. & Steel Inst. Gives a summary of the author's researches and the conclusions. 4500 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72517 A.

See Also Mechanical Engineering, Machine works and Foundries.

See Also Mechanical Engineering, Materials.

MINING.

Ankylostomiasis.

Ankylostomiasis: A Critical Study. The present number is largely introductory; stating the serious nature of the disease, and reviewing the history of the Westphalian epidemic. 2000 w. Col Guard—Oct. 20, 1905. Serial. 1st part. No. 72873 A.

Check Sampling.

Check Sampling the Great Fingall Mine, Western Australia. Charles M. Rolker. Describes the methods, giving results. 3800 w. Min Jour—Sept. 30, 1905. No. 72471 A.

Desulphurization.

The Carmichael-Bradford Process. Illustrated description of this process, which has been put into practical use at Broken Hill, N. S. W. 2000 w. Eng & Min Jour—Oct. 28, 1905. No. 72853.

Explosives.

The Ignition of Explosives (Ueber Zündung von Sprengstoffen). C. E. Bichel. A paper before the Mining Congress at Liége discussing the non ignition of high explosives by impact, with tabulated results of experiments upon a variety of materials. 3500 w. Glückauf—Sept. 23, 1905. No. 72736 D.

Hoist.

Electric Hoist at the Tiremande Colliery. Emile Guarini. Illustrates and describes a novel arrangement in which the hoist is placed at top of head-frame. 1200 w. Mines & Min—Oct., 1905. No. 72417 C.

Mine Buildings.

Tile vs. Brick for Mine Buildings. William L. Affelder. Statements in regard to cost and adaptability of tile for purposes for which brick is commonly used. 1200 w. Mines & Min—Oct., 1905. No. 72421 C.

Olympia Exhibition.

Electrical Exhibition at Olympia. Begins a description of such exhibits as are of interest to the mining engineer. 3000 w. Col Guard—Oct. 6, 1905. Serial, 1st part. No. 72543 A.

Ore Treatment.

The Treatment of Tin-Wolfram-Copper Ores at the Clitters United Mines. F. Dietzsch. Read before the Inst. of Min. & Met. An illustrated account of the reopening of these old Cornish mines and the modern methods introduced. 4000 w. Min Jour—Oct. 21, 1905. Serial. 1st part. No. 72872 A.

Prospecting.

What Veins to Choose. Prof. Arthur Lakes. Discusses indications likely to be found when prospecting in a region of crystalline rocks. 1800 w. Mines and Min—Oct., 1905. No. 72420 C.

Pyrite.

Pyrite Mining in St. Lawrence County, New York. Robert B. Brinsmade. Gives the location of these mines and describes the development of the three producing mines. 1800 w. Eng & Min Jour—Oct. 28, 1905. No. 72848.

Quarrying.

Marble Quarrying at Gouveneur, N. Y. Robert B. Brinsmade. An illustrated description of the marble and methods of quarrying. 2000 w. Eng & Min Jour—Oct. 21, 1905. No. 72645.

Rand.

Electric Power Distribution for the Rand. Robert Hammond. Read before the British Assn., at Johannesburg. A discussion of the problem of supplying electrical energy for the mines, the cost, etc. Also short discussion. 6800 w. Elect'n, Lond—Sept. 29, 1905. No. 72469 A.

Rock Drilling.

Notes on the Construction and Practical Operation of Rock-Drilling Machines. E. M. Weston. Notes on practical work at machine drilling, giving information of value. 10000 w. Jour Chem, Met & Min Soc of S Africa—Aug., 1905. No. 72676 E.

Safety Appliances.

Invention to Guard Against Deadly Gases. Illustrated description of an apparatus for rescue work in firedamp. Also statistics concerning explosions in Wales. 2000 w. U S Cons Repts—Sept., 1905. No. 72901 D.

Saving Life in Mines. Illustrates and describes an apparatus invented to guard against deadly gases in mines, devised by Professors Bemberger and Böck, of Vienna. 900 w. Min Rept—Oct. 12, 1905. No. 72558.

Sampling.

Hand Sampling in Small Stamp Mills. A. W. Warwick. Discusses the effects of careless sampling methods, with suggestions for accurate sampling. 1400 w. Min & Sci Pr—Oct. 21, 1905. No. 72892.

Shaft Boring.

New Shaft-Boring Apparatus. Illustrates and describes an interesting invention shown at the Liége Exhibition. The inventors are Messrs. Frieh and Nöllenburg. 1200 w. Col Guard—Oct. 20, 1905. No. 72874 A.

Sketching.

Mining Sketches. Prof. Arthur Lakes. Describes the making of geological and topographical drawings of a large district, and perspective underground sketching. 2300 w. Ills. Mines & Min—Oct., 1905. No. 72418 C.

Sliming.

A Discussion of Sliming Tables. J. C. Bailar. Read before the West. Assn. of Tech. Chem. & Met. Also a discussion of Hand Sampling in Small Stamp Mills, by A. W. Warwick, and a general discussion. 3500 w. Min Wld—Oct. 21, 1905. No. 72663.

Stamp Mills.

How to Cure a Rocking Mortar in a Stamp Mill. Paul J. Johnson. Discusses the cause of rocking mortars, and explains the writer's method of remedying the trouble. Ills. 900 w. Min Rept—Oct. 26, 1905. No. 72894.

Supplies.

The Card System for Mine Supplies. W. M. Jeffrey. Read before the L. Sup. Min. Inst. Outlines a card system of accounting, stating its advantages. 4000 w. Eng & Min Jour—Oct. 28, 1905. No. 72855.

Winding.

Wire Ropes for Winding Purposes. R. Hunter. Read before the Mine Mgrs.' Assn., Queensland. Reviews briefly the history of wire ropes, the class used for winding purposes, laws relating to winding-ropes, testing, &c. 2500 w. Queens Gov Min Jour—Aug. 15, 1905. Serial. 1st part. No. 72372 B.

MISCELLANY.

Aluminum.

Aluminum and Bauxite. Charles C. Schnatterbeck. Extract from Mineral Resources of U. S. Geol. Surv. Information concerning the aluminum industry, the prices, chief alloys, uses, &c. Also the output of bauxite and its value. 2600 w. Min Wld—Oct. 14, 1905. No. 72556.

Assaying.

The Assaying of Zinc Ores as Carried On in the Joplin District, Missouri. E. W. Buskett. Describes the laboratory equipment and methods commonly used. 2500 w. Mines & Min—Oct., 1905. No. 72413 C.

Diamonds.

Australia's Largest Diamond. John Plummer. Information concerning the discovery, with description of the gem, and discussion of its source, &c. 1200 w. Min Wld—Oct. 21, 1905. No. 72664.

Fertilizer.

A Valuable Bat Cave in New Mexico. F. W. Brady. Remarkable caves containing extensive deposits of dry guano are illustrated and described. 1000 w. Mines & Min—Oct., 1905. No. 72412 C.

Lead.

Lead-Smelting at Monteponi, Sardinia. Erminio Ferraris. Trans. from *Oest. Zeit. f. Berg- und Hüttenwesen.* Illustrated description of the smelting works and methods. 1500 w. Eng & Min Jour—Oct. 28, 1905. No. 72854.

Lime Roasting of Galena. W. Maynard Hutchings. Discusses the Huntington-Heberlein treatment and other systems, and reports experimental investigations. 2700 w. Eng & Min Jour—Oct. 21, 1905. No. 72644.

The Lead Ores of Southwestern Missouri. C. V. Petraeus and W. George Waring. Describes these deposits, their treatment, value, &c., reviewing the development of the industry. 1200 w. Eng & Min Jour—Oct. 21, 1905. No. 72642.

The Huntington - Heberlein Process from the Hygienic Standpoint. A. Biernbaum. Translated from the *Zeitschrift für das Berg-, Hütten und Salinenwesen.* Discusses the improvement in danger from lead-poisoning. 2500 w. Eng & Min Jour—Oct. 14, 1905. No. 72525.

Metals.

Crystalline and Amorphous States of Metals. Editorial review of the presidential address of Mr. G. T. Beilby, before the Chemical Section of the British Association at Johannesburg. On the researches in regard to the hard and soft states of metals. 2500 w. Engng—Sept. 22, 1905. No. 72316 A.

Molybdenite.

Molybdenite in British Columbia. Horace F. Evans. Describes its occurrence and the area. But little development work has been done. 1800 w. Min Wld—Oct. 21, 1905. No. 72665.

Monazite.

Monazite in the Beach - Sands of Queensland. B. Dunstan. Describes the deposits and the mineral, giving localities where it has been found. 1100 w. N Z Mines Rec—Aug. 16, 1905. No. 72866 B.

Petroleum.

Petroleum Boring at Wietze, Hannover (Die Erdölgewinnung bei Wietze, Prov. Hannover). W. Kaemmerer. Illustrated description of derricks and boring apparatus at Wietze-Steinförde where 41,000 metric tons of petroleum were produced in 1903. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 1905. No. 72702 D.

The Baker Oil-Fields in 1904. A. Beeby Thompson. Information from recently published statistics concerning production, cost, &c. 3500 w. Engng—Oct. 20, 1905. No. 72875 A.

Selenium.

Calorimetric Estimation of Selenium. J. E. Clennell. Gives a method for the rapid approximate estimation of small quantities of selenium in ores, bullion, smelting-room products, zinc-gold precipitates, cyanide solutions, &c. 900 w. Eng & Min Jour—Oct. 28, 1905. No. 72852.

Statistics.

The Mineral Industries of the United States. E. C. Eckel. A carefully classified review of the mineral products of the United States, showing their relative importance and growth. 3500 w. Engineering Magazine—Nov., 1905. No. 72789 B.

Sulphuric Acid.

Sulphuric Acid Manufacture. F. Luety. Abstract translation of a paper in *Zeit. für angewandte Chemie.* Reviews the principal modern improvements in the sulphuric-acid chamber-process, and deals more in detail with a method due to H. H. Niedenfuehr. Ills. 2500 w. Eng & Min Jour—Oct. 7, 1905. No. 72431.

Tap Jackets.

The Evolution of Tap Jackets and Spouts. Hiram W. Hixon. Describes the tap jackets used in lead smelting; and the furnace spouts used in copper smelting. 1200 w. Eng & Min Jour—Oct. 14, 1905. No. 72523.

Tin.

Tin Mining in Tasmania. Hartwell Conder. Reviews briefly the past history, and describes present conditions. 1800 w. Min Jour—Sept. 30, 1905. No. 72472 A.

Troostite.

The Nature of Troostite. Dr. Carl Benedicks. Abstract of a paper read before the Ir. & Steel Inst. Examines arguments of other investigators, and gives the writer's conclusions. 1200 w. Ir & Coal Trds Rev—Sept. 29, 1905. No. 72515 A.

Vanadium.

Applications of Vanadium in Metallurgy (Emplois du Vanadium en Métallurgie). Léon Guillet. An account of the sources of vanadium, the preparation of ferro-vanadium and the properties of vanadium alloy-steels. Serial. Part I. 1800 w. Génie Civil—Oct. 14, 1905. No. 72773 D.

Zinc.

The Electric Smelting of Zinc Ores. Frederick T. Snyder, in Trans. of the Can. Min. Inst. Describes the present method of smelting on a lead basis ores containing gold and silver, comparing with a gas producer and gas engine dynamo system, and a system when the water-wheel replaces the gas producer and gas engine. 2500 w. Can Min Rev—Oct., 1905. No. 72561 B.

The Properties of Sheet Zinc (Ueber die Eigenschaften von Zinkblech). Dr. Oswald Meyer. Data and results of tests upon plates of zinc for tension, flexure and elasticity. Two articles. 1 plate. 5000 w. Oesterrr Zeitschr f Berg u Hüttenwesen—Oct. 7, 14, 1905. No. 72742 each D.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Car Handling.

Per Diem. W. G. Hunter. Short paper introducing a general discussion of this subject. 4500 w. Pro Iowa Ry Club—Sept. 11, 1905. No. 72608 C.

Hospital Car.

Hospital Car, Southern Pacific Company. Illustrated detailed description of a fine car equipped for the service of a well appointed hospital. 1500 w. Ry & Engng Rev—Oct. 28, 1905. No. 72895.

Organization.

The Organization of Railway Shop Forces. H. T. Bentley. Discussion of the requisites necessary to obtain the best results. General discussion follows. 10000 w. Pro W Ry Club—Sept. 19, 1905. No. 72610 C.

Payment.

Cash versus Checks in Paying Railway Employes. Gives arguments that have been suggested against and in favor of each of the methods of payment. 4000 w. Ry Age—Sept. 29, 1905. No. 72338.

Train Services.

Summer Train Services in 1905—British and French. Charles Rous-Marten. A review of the improvement in fast service and a comparison to England's disadvantage. 3000 w. Engr, Lond—Oct. 6, 1905. No. 72553 A.

MOTIVE POWER AND EQUIPMENT.

Brakes.

High Speed Brakes. Robert Burgess. Explains the action of high-speed brakes, the apparatus and the effects. General discussion. Ills. 8000 w. S & S-W Ry Club—Aug. 17, 1905. No. 72522 E.

Brake Trials.

Special Fifty-Car Train Demonstrations at West Seneca, N. Y. A report of the tests made August 23, at West Seneca, N. Y. 1600 w. Ry & Loc Engng—Oct., 1905. No. 72428 C.

Cars.

Buffalo & Susquehanna Dump Car. Illustration and brief description of a side dump coke car of large capacity and minimum weight. 400 w. Ry & Loc Engng—Oct., 1905. No. 72426 C.

Self-Discharging Single-Hopper Wagon; Prussian State Railways. Illustrations, with brief description. 300 w. Engng—Oct. 13, 1905. No. 72685 A.

Steel Wagon Construction in the United States. Notes on the general methods of a modern American steel car shop which tend to rapidity of manufacture. 1800 w. Engr, Lond—Oct. 13, 1905. No. 72690 A.

The Evolution of the Coal Car. C. H. Caruthers. An interesting review, with illustrations. 2200 w. R R Gaz—Vol. XXXIX., No. 16. No. 72651.

Electrification.

An Unprecedented Railway Situation. Frank J. Sprague. Analyzes the conditions which will be brought about by an attempt to utilize a. c.—d. c. locomotives in the present d. c. zone of the New York Central & Hudson River R. R. Co., outlining the situation and discussing both electrical and operating features. 5000 w. St Ry Jour—Oct. 21, 1905. No. 72659 C.

Electric Traction for Railroad Service. J. A. Shaw. Read before the Can. Ry. Club. Discusses the advantages of electricity over steam, the systems at present available for heavy electric traction, and the merits of each. 3500 w. Eng Rec—Oct. 14, 1905. No. 72567.

Electrification of Railways. H. W. Wilson. Read before the Liverpool Engng. Soc. Outlines various methods of electrical operation of railways and considers their adaptability to varying conditions. 5000 w. Mech Engr—Sept. 30, 1905. Serial. 1st part. No. 72458 A.

Niagara Electric Power for Steam Railways of Western New York. Mentions new fields for large amounts of electric power and reviews what has been done and is being done in the line of generating stations in the vicinity of Niagara Falls. Ills. 6000 w. Ry & Engng Rev—Oct. 14, 1905. No. 72554.

Locomotive Building.

Locomotive Building in New South Wales. Editorial review of the industrial history that has led to the giving of the contract for sixty locomotives within the State of New South Wales. 1700 w. Engng—Sept. 22, 1905. No. 72317 A.

Locomotives.

Articulated Locomotives. Charles S. Lake. Illustrates and describes several types of articulated locomotives, which are well suited for working round curves of small radius and on steep gradients. 2800 w. Mech Engr—Oct. 14, 1905. No. 72673 A.

A Study of American Locomotives. M. J. Oudet. Translated from *Revue Mécanique*. Discusses the design of American locomotives, and some of the reasons why the prices of manufacture are lower than in other countries. 1400 w. R R Gaz—Vol. XXXIX., No. 16. No. 72649.

Balanced Compound Locomotive, P. R. R. Illustrations and general dimensions of a new Cole compound passenger engine. 600 w. Ry & Engng Rev—Oct. 7, 1905. No. 72440.

Compound Articulated Locomotive for the Northern Railway of France. H. W. Hanbury. Illustrated detailed description of an engine exhibited at Liége, which is attracting much attention because of its novel design. It is to be used for coal traffic which is exceedingly heavy. 2200 w. Engng—Oct. 6, 1905. No. 72547 A.

Freight Locomotive 4-6-0 Type. Illustration and dimensions of locomotives to which Walschaert valve gear has been applied. A ten-wheel type for the C., R. I., & P. Ry. 250 w. Am Engr & R R Jour —Oct., 1905. No. 72367 C.

French 6-2-2-6 Compound Freight Locomotive. Illustrated description of a new design for hauling heavy coal trains over variable grades. 900 w. Ry & Engng Rev—Oct. 7, 1905. No. 72443.

Heavy Passenger Locomotive for Lackawanna. Illustrates and describes what is believed to be the heaviest passenger locomotive ever built in the 10-wheel type. 500 w. Ry Age—Oct. 27, 1905. No. 72847.

Lackawanna Locomotive with Schenectady Superheater. Illustrated description of the eight-wheeled (4-4-0) locomotive recently built and fitted with the Cole superheater. 900 w. R R Gaz—Oct. 15, 1905. No. 72510.

Locomotives at the St. Louis Exposition (Les Locomotives à l'Exposition de Saint Louis). A general review of the engines exhibited, with illustrations and a comparative table. 4000 w. Rev Gen d Chem de Fer—Sept., 1905. No. 72726 G.

Locomotives for the Panama R. R. Illustrates one of the engines of the 2-6-4 type, 24 of which are now ready. 500 w. Ry & Engng Rev—Oct. 28, 1905. No. 72896.

Passenger Belpaire Engines, Midland Railway. Illustration and particulars of a new express locomotive. 300 w. Engr, Lond—Sept. 29, 1905. No. 72480 A.

Prairie Type Engine for the Chicago, Burlington & Quincy. Illustrates and describes the interesting features of these engines, giving general dimensions. 900 w. R R Gaz—Vol. XXXIX., No. 16. No. 72647.

Six-Coupled Passenger Locomotive, London and North-Western Railway. 2-page plate and drawings, with principal dimensions and notes. 400 w. Engr, Lond—Oct. 6, 1905. No. 72552 A.

Sixteen-Wheel Double Tank Locomotive for the Northern Railway of France. Illustrated detailed description of an interesting engine shown at the recent exposition at Liége, Belgium. 1500 w. R R Gaz—Vol. XXXIX., No. 14. No. 72406.

The Distribution of Weight in Locomotives. Jas. Horsfall. Begins with a study of the four-wheeled engine, using the graphic method. 1500 w. Prac Engr —Oct. 6, 1905. Serial. 1st part. No. 72536 A.

Motor Cars.

Gasoline Motor Car No. 2, U. P. R. R. Illustrated description of this car and its improvements over car No. 1. Its strength is one of the most interesting features. 1200 w. Ry & Engng Rev—Oct. 7, 1905. No. 72442.

Motor Cars for Railway Service (Motorwagen im Eisenbahnbetriebe). A. Heller. A fully illustrated account of various types of self-propelled cars for local railway service, using both steam and gasoline. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 1905. No. 72700 D.

Steam Motor Cars on the Taff Vale Ry., England. Drawings and description. 600 w. Eng News—Oct. 5, 1905. No. 72402.

Rolling-Stock.

The Earning Power of British Rolling Stock from 1894 to 1903. W. Pollard Digby. Gives tables showing the rolling stock, the railway earnings, the average earnings per locomotive, and other statistics of interest. 2500 w. Engr, Lond—Sept. 22, 1905. No. 72320 A.

Traction.

The Computation of the Loads for the

Locomotives of the Danish State Railways (Determination des Charges à Appliques aux Locomotives des Chemins de Fer de l'Etat Danois). Formulas and curves showing the hauling capacity of the engines at various speeds. 1200 w. Génie Civil—Oct. 7, 1905. No. 72713 D.

Train Lighting.

Dissolved Acetylene. Discusses the manufacture of this gas, as given in a recent paper by Herr Kuchel, and the process of using it, especially in regard to its application for the illumination of trains. 3300 w. Engr, Lond—Oct. 20, 1905. No. 72887 A.

Signal Lamps.

The Design, Construction, Efficiency and Maintenance of Signal Lamps. Report of committee of Railway Signal Assn., at Niagara Falls meeting. Discussion and report of tests, maintenance, conclusions, &c. 6500 w. Eng News—Oct. 19, 1905. No. 72586.

Valve Gears.

New American Valve Gears for Locomotives. Illustrates and describes the Alfree valve gear, and the Young locomotive valve gear. 1200 w. Engr, Lond—Oct. 20, 1905. No. 72886 A.

The Construction of the Link of the Heusinger-Walschaert Valve Gear (Die Konstruktion des Schleifbogens der Heusinger Steuerung). W. Hanff. Giving equations and diagrams for laying out slide-valve gears of the Walschaert type. 800 w. Zeitschr d Ver Deutscher Ing—Oct. 7, 1905. No. 72706 D.

The Stephenson and Walschaert Valve Gears. James Kennedy. Describes the Walschaert valve gear, stating its apparent advantages. Ills. 1800 w. Ry & Loc Engng—Oct., 1905. No. 72427 C.

Valve Tests.

Tests of the Westinghouse Improved Quick-Service Triple Valves. A report of tests made at West Seneca, N. Y., showing the ability of modern brake apparatus and friction draft gear to meet the present severe service conditions of train operation. 1700 w. R R Gaz—Vol. XXXIX., No 16. No. 72648.

Ventilation.

Car Ventilation. Ross Taylor. Brief paper followed by discussion, in which Round House ventilation is also discussed. 5000 w. Pro St Louis Ry Club—Sept. 8, 1905. No. 72342.

NEW PROJECTS.

Austria.

The Tauern Railroad from Schwarzach to Bad Gastein. Emil S. Fischer. Illustrated description of this recently opened road which passes through some of the highest and most picturesque parts of the Eastern Alps. 1800 w. Ry & Engng Rev—Oct. 21, 1905. No. 72666.

Extension.

Recent Work on the Indiana Harbor R. R. Begins an illustrated detailed description of the construction of an extension from Lake Michigan to Danville, Ill. 3500 w. Eng Rec—Sept. 30, 1905. Serial. 1st part. No. 72359.

Florida Keys.

The Florida East Coast Extension to Key West. An illustrated account of this projected extension, now under construction, which will afford greatly improved facilities for communication between Cuba and the mainland. 1000 w. R R Gaz—Vol. XXXIX., No. 14. No. 72407.

PERMANENT WAY AND BUILDINGS

Coal Storage.

Lehigh Valley Coal Storage Plant. Illustrations, with brief description, of the plant at Wyoming, N. Y., 20 miles from Buffalo, for storing anthracite coal. 600 w. Ry Age—Sept. 29, 1905. No. 72339.

Interlocking.

The Cost of Stopping Trains, Compared with the Cost of Maintenance, Operation and Inspection of Interlocking Plants. J. A. Peabody. Read at the convention of the Ry. Sig. Assn. Gives statistics showing the costs as derived from experiments, and tables showing the saving to be effected by interlocking plants. 1500 w. Eng News—Oct. 12, 1905. No. 72498.

Power Plant.

Modern Railroad Terminal Power Plant. Illustrates and describes the fine generating station of the New York Central & Hudson River Railroad at Weehawken, N. J. 3500 w. Am Elect'n—Oct., 1905. No. 72381.

Reconstruction.

Rebuilding the Cairo Division of the Big Four. Describes the condition of this portion of the line, giving an illustrated account of the reconstruction in progress to prepare it for the heavy traffic due to development of immense coal fields. 2500 w. R R Gaz—Vol. XXXIX, No. 17. No. 72824.

Shops.

Blacksmith Shop. Illustrates and describes this part of the plant of the Angus shops, Montreal. 1200 w. Am Engr & R R Jour—Oct., 1905. No. 72368 C.

South Louisville Shops, Louisville and Nashville R. R. An illustrated description of the large new repair and manufacturing plant recently put into operation. 5500 w. Ry & Engng Rev—Oct. 7, 1905. Serial. 1st part. No. 72441.

Sierra Leone.

A West-African Railway: The Sierra Leone Line. J. Hartley Knight. Describing the construction of a British pioneer railway connecting the interior with the West Coast and aiding in developing commerce. 2000 w. Engineering Magazine—Nov., 1905. No. 72787 B.

Signaling.

Normal Danger vs. Normal Clear. C. H. Platt. States the important reasons published for favoring the normal clear system, discussing each in detail and favoring the normal danger system. 1500 w. R R Gaz—Vol. XXXIX., No. 15. No. 72508.

Report of Committee No. 13 on Rubber-Covered Wire. Report presented to the convention of the Railway Signal Association. Suggestions as to requirements and tests, with reasons. 2800 w. Elec Rev, N Y—Oct. 28, 1905. No. 72819.

Signal Lenses. A. G. Wilson. Discusses the lenses now applied to railroad lamps, the tests that should be made, &c. 1400 w. R R Gaz—Vol. XXXIX., No. 14. No. 72408.

Terminals.

New Freight Terminal at Cincinnati, of the Cincinnati, New Orleans and Texas Pacific. Illustrates and describes this new terminal, giving a map showing its location. 1500 w. R R Gaz—Vol. XXXIX., No. 13. No. 72340.

Terminal Improvements of the New York Central & Hudson River in New York. G. R. Wadsworth. Illustrated detailed description of the extensive alterations and important changes in progress. 2800 w. R R Gaz—Vol. XXXIX., No. 16. No. 72650.

Ties.

New Concrete Ties and Steel Ties. Brief illustrated descriptions of two forms of reinforced concrete ties now being tested, and a new design of steel tie which is now in service under exceptionally heavy traffic. 900 w. Eng News—Oct. 5, 1905. No. 72401.

Water Tanks.

Protection of Water Tanks from Action of Frost. From a Committee report to the Assn. of Ry. Supts. of Bridges & Buildings. Gives extracts from a circular of inquiry, and summary of information received. Ills. 3000 w. Ry & Engng Rev—Oct. 28, 1905. No. 72897.

TRAFFIC.

Freight.

Following Up Time, Fast or Carded Freight. P. D. Satchwell. Describes a carefully worked out system, known as the "Best by Test.' 1700 w. Ry Age—Oct. 20, 1905. No. 72646.

Freight Seals.

Seals for Freight Cars. An explanation of the plan of sealing freight cars and its value in tracing any theft of freight. 1200 w. Sci Am Sup—Oct. 7, 1905. No. 72450.

New South Wales.

New South Wales Railways. Editorial review of the report of the Commissioners for the year ending in June, 1905, which shows an increase in nearly every department of traffic. 2000 w. Engng—Oct. 20, 1905. No. 72880 A.

MISCELLANY.

British Railways.

Notes on British Railways. Angus Sinclair. An explanation of how circumstances influenced the growth of railways. 1400 w. Ry & Loc Engng—Oct., 1905. No. 72425 C.

STREET AND ELECTRIC RAILWAYS

Accounting.

Accounting with Four Departments. H. M. Beardsley. Read before the St. Ry. Accountants' Assn. Describes the methods in use at Elmira, N. Y. 3000 w. St Ry Rev—Oct., 1905. No. 72639 C.

Interurban Ticket Accounting. J. H. Pardee. Read before the St. Ry. Acc. Assn. Describes the system in use on the Rochester & Eastern Rapid Railway. 1000 w. St Ry Rev—Oct., 1905. No. 72640 C.

Belfast.

Belfast City Tramways. Illustrated detailed description of an extensive electric system of the latest designs. 11700 w. Tram & Ry Wld—Oct. 12, 1905. No. 72696 B.

Berlin-Zossen.

The Berlin-Zossen Tests of 1902. Abstracts of the results of the 1902 tests of train resistance and braking at high speed. 4800 w. St Ry Jour—Oct. 28, 1905. No. 72902 C.

Brake.

An Emergency Track Brake. F. F. Bodler. Read before the Am. Ry., Mech., & Elec. Assn. Illustrates and describes this brake which is used on almost all of the cars in San Francisco. 1000 w. St Ry Jour—Sept. 30, 1905. No. 72354 C.

Chicago.

The Street Railways of Chicago. Part of an address by Mayor Dunne before the League of Am. Munic. explaining his scheme for securing early municipalization. 2500 w. Munic Jour & Engr—Oct., 1905. No. 72326 C.

Cleveland.

New Operating Features in Cleveland. Illustrates and describes a test car, derrick car, stone crusher, concrete conveyor, new track construction, &c. 1500 w. St Ry Jour—Oct. 14, 1905. No. 72529 C.

Collision.

The Hall Road Collision. A review of the report of Lieut.-Col. Druitt, who was appointed to conduct the inquiry into the cause of the collision which occurred on July 27, on the electric railway. 1700 w. Engr, Lond—Oct. 20, 1905. No. 72885 A.

Compressed-Air.

An Industrial Compressed Air Railway. C. B. Hodges. Illustrated description of the compressed-air system of transportation at the new reduction works of the Anaconda Copper Mining Company, at Anaconda, Montana. 3000 w. Cassier's Mag—Oct., 1905. No. 72625 B.

Construction.

Overhead Construction. Robert N. Tweedy. Discussing some details in connection with poles, wiring, &c., and referring to paper by Mr. Sayers. 2000 w. Elec Rev, Lond—Oct. 20, 1905. Serial. 1st part. No. 72869 A.

Controller.

The Series-Parallel Railway Controller. W. A. Pearson. Read before the Am. Ry., Mech., & Elec. Assn. Reviews the development of the series-parallel controller for street-car service, and describes the methods of making the series to parallel change. 2500 w. St Ry Jour —Sept. 30, 1905. No. 72351 C.

Distribution.

The Power Distributing System of the Boston Elevated Railway Company. C. H. Hile. Read at convention of the Am. Ry., Mech., & Elec. Assn. Describes this system of separate power plants, with their interconnected power distributing systems, giving facts, results and experiences as representative of such engineering practices. 4000 w. St Ry Jour—Sept. 30, 1905. No. 72348 C.

Electric Locomotives.

Metropolitan Railway Electric Locomotives. Brief illustrated description of the 150-ton electrical locomotives being supplied. 600 w. Engr, Lond—Sept. 22, 1905. No. 72323 A.

Electric System.

The New Haven's Electric Railway System. Reviews the history of the upbuilding of this system. Map. 1200 w. R R Gaz—Vol. XXXIX., No. 17. No. 72823.

Electric Traction.

Discussion on "Heavy Electric Freight Traction," at Asheville, N. C. 4000 w. Am Inst of Elec Engrs—Sept., 1905. No. 72839 D.

Progress in Electric Traction (Fortschritte auf dem Gebiete der Elektrischen Zugförderung). Friedrich Eichberg. Describing especially recent three-phase and single-phase interurban lines in Germany and Austria. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 23, 1905. No. 72701 D.

Electrification.

See Railway Engineering, Motive Power.

Equipment.

Electric Railway Equipment. W. B. Potter. Read before the Am. Ry., Mech., & Elec. Assn. Considers a few of the features relating to the development of the past few years—steam turbines, motors, controlling, car wiring, fuses, &c. 3500 w. St Ry Jour—Sept. 30, 1905. No. 72358 C.

Gas Power.

The Application of Gas Power to Electric Railway Service. J. R. Bibbins. Read before the Am. Ry., Mech., & Elec. Assn. Aims to show the adaptability of the gas engine and producer to street railway service, giving results that have already been attained in driving electrical machinery. Ills. 5000 w. St Ry Jour—Sept. 30, 1905. No. 72356 C.

Hastings.

Hastings Electric Tramways. Illustrated description of a system of interest because of the extremely steep grades and sharp curves. 3000 w. Elect'n, Lond—Oct. 13, 1905. No. 72680 A.

The Tramway System of Hastings. Full illustrated description of a system having features of interest. 5000 w. Tram & Ry Wld—Oct. 12, 1905. No. 72697 B.

Instruction.

The Policy of More Liberal Instruction for Motormen. Edward Taylor. A discussion of the system of instruction which will best fit the motorman for his duties and responsibilities. 5500 w. St Ry Rev —Oct., 1905. No. 72637 C.

Insulation.

The Insulation of Overhead Lines. W. B. Esson. Discusses the materials used, the design of insulators, illustrating and describing examples of recent practice. 2200 w. Engr, Lond—Oct. 6, 1905. No. 72549 A.

Interurban.

Interurban Fare Collections. Irwin Fullerton. Read before the St. Ry. Acc. Assn. Describes the system in effect on the Detroit United Ry. system. 1500 w. St Ry Rev—Oct., 1905. No. 72641 C.

The Toledo & Indiana Railway. Illustrated description of a recently opened extension from Wauseon to Bryan. 5500 w. St Ry Jour—Oct. 21, 1905. No. 72658 C.

London Underground.

The Electrification of the London Underground Railway (Die Einführung des Elektrischen Betriebes bei den Vereinigten Londoner Stadtbahnen). K. Meyer. A general description of the conversion work, with details of the substations, cars and roadbed. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 7, 1905. No. 72705 D.

Multiple Unit.

Multiple Unit Systems of Train Control. Hugh Hazelton. Read at convention of Am. Ry., Mech., & Elec. Assn. Describes the two types of multiple-control apparatus now in use, illustrating details, and showing the merits of the system for interurban and street railway lines. 3000 w. St Ry Jour—Sept. 30, 1905. No. 72350 C.

New York Subway.

The New York Rapid Transit Railway. The present article explains the conditions on Manhattan Island and begins an illustrated detailed description of the construction of the rapid transit subway. 2000 w. Engr, Lond—Oct. 13, 1905. Serial. 1st part. No. 72691 A.

Power House.

The Missouri-River Power-House of the Metropolitan Street Railway Company, Kansas City, Missouri. F. G. Cudworth. Illustrated detailed description of the 40,000 K. W. station of the Metropolitan Street Railway Co. 8000 w. Eng News—Oct. 19, 1905. No. 72585.

Power Plant.

The Power Plant of the Boston & Worcester Street Railway. Howard S. Knowlton. Illustrated detailed description. 2500 w. Eng Rec—Oct. 14, 1905. No. 72570.

Rail-Joints.

The Treatment of Rail-Joints. A series of papers assembled and edited by Fred G. Simmons, describing the practice of the electric street and interurban railways of America. Ills. Presented before the Am. Ry., Mech., & Elec. Assn. 10500 w. St Ry Jour—Sept. 30, 1905. No. 72352 C.

Single Phase.

Electric Traction by Single Phase Alternating Currents (Traction Electrique par Courant Alternatif Monophase). M. Auvert. Describing a system in which the alternating current is converted into a continuous one by a rectifier carried on the locomotive. 7000 w. 1 plate. Rev Gen de Chem de Fer—Oct., 1905. No. 72727 G.

The Single-Phase Railway. M. P. Randolph. Read at the Portland exposition congress. Describes the particular features of the alternating-current series motor, also details of the car equipment, and other matters relating principally to interurban service. 4000 w. Jour of Elec —Oct., 1905. No. 72575 C.

"The Single-Phase Railway" and "Electric Railway Equipment." Abstract of a paper by W. B. Potter, and abstract of a discussion of both Mr. Scott's and Mr. Potter's papers. 4500 w. Elec Rev, N. Y —Oct. 28, 1905. No. 72820.

The Single-Phase Railway System. Charles F. Scott. Read before the Am. Ry., Mech., & Elec. Assn. Presents the important features of this system, and the results of the work accomplished in developing apparatus to meet the demands in electric traction. 4000 w. St Ry Jour —Sept. 30, 1905. No. 72357 C.

Three-Phase.

Discussion on "Three-Phase Traction," at Asheville, N. C. 7500 w. Am Inst of Elec Engrs—Sept., 1905. No. 72838 D.

Toronto.

The Toronto Street Railway Agreement. Francis S. Spence. Read before the Toledo convention of the League of Am. Munic. Gives the history and the details of the agreement under which the company operates, explaining the situation. 3000 w. Munic Jour & Engr—Oct., 1905. No. 72325 C.

Trackless.

Trackless Trolleys (Gleislose Bahnen). W. Butz. Illustrating recent progress in electric traction on common roads with overhead trolleys for the supply of current. Illustrations are given of omnibus equipment and of trains of trailers for merchandise. 3500 w. Eisenbahntech Zeitschr—Sept. 6, 1905. No. 72774 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.

Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad.des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe,U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Hydraulics.

Hydraulic Tables. By Gardner S. Williams and Allen Hazen. Size, 9 in. by 6 in.; pp. iv, 75. Price, $1.50. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

This modest little volume is a valuable addition to one of the most important departments of engineering. For a long time the study of the flow of water in pipes and channels has been hampered by the incubus of an idea that a formula devised nearly a century ago by Chézy was correct. This formula stated that the velocity of flow was dependent upon the square root of the hydraulic slope times the hydraulic radius, a constant coefficient being also involved. The trouble with the formula was that the constant was not constant, but altogether erratic and unreliable. Kutter, the Swiss engineer, tried to improve matters, and devised a formula for computing the constant coefficient, but the trouble with his formula was that it involved another coefficient, called the coefficient of roughness, which had to be guessed at, according to the ideas of the engineer as to the nature of the channel or pipe under consideration. The result was that a quantity of elaborate computations had to be made, using data which were dependent altogether upon the judgment of the man who was doing the work. The whole performance suggests the old story of the manner in which a certain shop sold its scrap iron, that is, by having everybody in the office look at the scrap heap and guess at its weight, and then averaging the guesses.

In late years some American engineers, among whom may be mentioned Fenkell and Tutton, became possessed of a sufficient spirit of heresy to suggest that perhaps Chézy was wrong, and that the formula was not in proper shape, and the result was a change in the value of the exponents, so that the formula has been modified in various ways and forms deduced in which the constant coefficient is really constant and not subject to change according to the opinion of the man making the computations. Messrs. Williams and Hazen have examined the subject in the light of these declarations of independence, and selected exponents and coefficients which agree very closely with the results of tests, and have tabulated the corresponding values for the flow of water in pipes, sewers, and other channels, the figures being computed by a modification of the slide rule made to correspond with their formula. The tables give the flow of water in pipes of various materials, and include slopes required to produce certain velocities, and the book will be found most useful to hydraulic engineers.

Power Plants.

Commercial Economy in Steam and other Thermal Power Plants. By Robert H. Smith. Diagrams by H. Malcolm Hodson. Size, 10 in. by 6 in.; pp. xxiv, 291. Price, 24 shillings. London: Archibald Constable & Co., Limited. Philadelphia: J. B. Lippincott Co.

The appearance of this book is evidence of the increasing attention which is being paid to the fact that the engineer must also be a business man. As Professor Smith says, the main endeavor of the book is to persuade the mechanical engineer to advance from the primitive view that engineering science can guide him only in the physical construction and the physical dynamics of his machinery, to the much more complete idea that scientific method must also be applied to his reckonings of cost and of value produced. The only true economy is an all-round economy, and mechanical pride in the difficult attainment of purely physical excellence must leave unshaken our readiness to sacrifice mechanical perfection to low cost in such degree as yields the best economic ratio of resulting value to working expenditure.

Professor Smith has produced a book which should be studied by every engineer who aims to design steam engines which shall have the highest economy, not of steam, nor of fuel, but of money. To this end he discusses the relation of commercial economy to physical efficiency, capital charges, and working costs, taking up first the subjects of production, profit, and economy in general, deriving what he calls the "economy-coefficient"; this consisting of product divided by cost and time. Having reduced the commercial elements involved to their mathematical relations, these are applied to the special subject of the true economical production of power from heat, the whole subject being given a strict mathematical treatment.

Believing that the engineer should not take refuge in approximations of dubious accuracy when correct computations are possible, the author has given the results of his studies mainly in curves, plotted upon such a large scale as to render the readings of sufficient precision for practical use, thus removing any excuse as to the impracticability of the mathematical treatment on the score of difficulty.

We have advocated for a long time the study of methods of cost-keeping and commercial accounting as related to the manufacture of the products of the machine shop, and we are only too glad to call attention to the able manner in which Professor Smith has developed the study of the scientific application of similar methods to the manufacture of power. The book is a most illuminating one, and should find a place in the library of every thoughtful engineer.

Space Telegraphy.

Wireless Telegraphy; Its History, Theory, and Practice. By A. Frederick Collins. Size, 9 in. by 6 in.; pp. xii, 300. Price, $3.00. New York: McGraw Publishing Company.

Mr. Collins, who is well known by his previous publications in the technical press upon the subject of telegraphic and telephonic communication through space by means of electrical waves, has given in this volume a very readable review of the present state of the art. Preceding the discussion of the practical side of the subject by chapters upon the ether, upon wave motion, and upon electrical discharges and oscillations, the author proceeds to examine the devices by which electrical waves may be made and received, followed by descriptions of the apparatus employed in the practical use of the theoretical principles. The book is especially valuable as a record of what has been done, gathering into convenient form the work of many investigators, and thus forming an account of the work already performed in a department of applied science which is undoubtedly in its early stages, and from which great developments may be expected.

BOOKS RECEIVED.

Hydraulic Power Engineering. By G. Croydon Marks. Price, 9 shillings ($3.50). London: Crosby Lockwood & Son. New York: D. Van Nostrand Co.

Theory of Structures and Strength of Materials. By Henry T. Bovey. Fourth Edition. Price, $7.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Cements, Limes, and Plasters. By Edwin C. Eckel. Price, $6.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Radio-Activity. By E. Rutherford. Price, 12 s. 6d. ($4.00). Cambridge: The University Press. New York: The Macmillan Company.

Soils and Fertilizers. By Harry Snyder. Price, $1.50. Easton, Pa.: The Chemical Publishing Company.

Electricians' Handy Book. By T. O'Conor Sloane. Price, $3.50. New York: The Norman W. Henley Company.

The Design and Construction of Metallic Bridges. By William H. Bur and Myron S. Falk. Price, $5.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Advanced Mechanical Drawing. By Alpha Pierce Jamison. Price, $2.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Principles of Electrical Power. By A. H. Bate. Price, 4s. 6d. ($1.75). London: E. & F. Spon, Ltd. New York: Spon & Chamberlain.

Physics. By Charles Riborg Mann and George Ransome Twiss. Price, $1.25. Chicago: Scott, Foresman & Co.

Machine Shop Tools and Methods. By W. S. Leonard. Price, $4.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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THE AMERICAN, AND THE GERMAN, "PERIL."

By Louis J. Magee.

I. THE INTERCHANGE OF EXPERIENCE BETWEEN NATIONS.

Mr. Magee's close association with some of the largest financial and industrial interests active in Germany and America gives him a peculiar insight into the commercial ideals of the two countries. His intimate personal acquaintance with the life and the social conditions in both lands fits him to see far beneath the surface, and to interpret each to the other with the insight possible only to a friend. But he writes throughout, as will be noticed, from the standpoint of an earnest, broad-minded, and deeply loyal American.

This introductory article will be followed by two more—the second dealing with "Differences and Contrasts in National Traits and Industrial Policy," and the third with "American Trade Methods Tested by German Experience." In view of the great and rapidly rising importance of Germany's position and aspirations as a world power in manufacture and commerce, and of the particular activity of interest in her future relations with the United States, these papers will be of great significance and, we trust, of real public value. —THE EDITORS.

THE curve traced by a nation's periodic "ups and downs" is in Germany's case approaching a new "peak." That people's commercial ascendency in Europe finds its analogy at another high part of the long curve four to six centuries earlier—the proud Hansa times. The Hanseatic League was a successful mediæval "Trust" formed in defiance of robber knights and Danish pirates, to make business safe and systematic in an Empire where there was no other community of interest, no order, and no protection for the "common merchant." This league of cities gained for its members a monopoly of practically all the products of Northern Europe, reached far into the Mediterranean countries, and, from its stronghold in London, the "Steelyard," laid a controlling hand on the trade of unawakened England. Its organization was efficient, its rules strict. Those early merchants developed a wonderfully practical system of distribution, warehousing, and exchange. The tapestries of Flanders, Rhenish wine, Skâne herring, Hamburg beer, English wool, and the furs of Novgorod—every luxury and necessity—was theirs alone to carry and to sell. But as a statesman long before our times has said, "the weak point of the League was that it had no backing of manufacturing interests." Today, however, German traders have a mighty home industry behind them; this is a serious combination.

Contrary to our ideas of crowded Europe, all but 9.3 per cent of the territory of the Empire consists of farms, forests, vineyards and moorland. About 18,000,000 of the population gain a living from agriculture, gardening, cattle raising, forestry and fisheries. But it is the 9.3 per cent town territory which we hear of in the outer world. There are 178,936 factories with 3,822,959 operatives. The labor conditions are considered comparatively favorable, although as many as 1,400 strikes take place in one year. The industries are frugally managed, and the quality of plant averages high. Raw materials are comparatively free from duties.

The accumulated business experience and routine of centuries, on the one hand; and the high scientific attainment, tremendous technical activity, and unsurpassed schools, on the other hand, combine to warrant the German manufacturers and exporters in expecting much for the future. They are, however, handicapped by a dearth of raw material, a very small home market, and by jealous particularism within the Empire; by strong national preferences, and in some cases high customs duties, among their neighbors. America's growing interest in the markets of the world has also of late become a new source of anxiety. The modern German business man reads the signs of what Americans may do when they seriously look abroad for business. He notices their growing strength and restlessness. "The American Peril" has become a newspaper phrase.

Europeans have, to be sure, for years invested in our railways. They have purchased our food stuffs and sent us manufactured goods that we could not make ourselves. Midway in the 80's, sewing machines and Mauser rifles were being built in Europe on the American system of interchangeability of parts and measured with gauges from Providence. Several factories were even then equipped with American tools. But despite all the points of contact, most leaders of European industry, finance, and politics left America, until very recently, out of their daily calculations. To-day it is the fashion in high business circles to be informed on things American. Especially Germany, which provides about three-quarters of all Continental initiative, is very seriously concerned in finding out what she can do to improve along American lines.

There are several definite causes which have combined to make America the new idea in Europe. Only recently have our promoters and capitalists had any large interests in the Old World. For example, see Mr. Yerkes' mastery of the London transportation problem, or the electrical, radiator, and air-brake factories built in England and on the Continent, largely with American capital and technical assistance. Our promoters however have only begun to look abroad. They are still too much occupied at home. American manufacturers likewise have only of late attacked the European markets systematically. Sometimes good things sell themselves, and for years ours did that. We are just learning the niceties of the export business, and just creating a market for such of our wares as must have their advantages proven by organized effort. A third cause of new interest in Yankee intentions was the formation of the United States Steel Corporation and the Shipping Combine and other trusts. These made a deep impression upon the *haute finance* of Europe. "Herr Pierpont Morgan" was abused in many languages. The Banks of Germany, contrary to the custom in this country, participate in the ownership, and have much to say regarding the management, of the iron works, rolling mills, shipyards, ocean lines, collieries, and electrical companies, so that their directors have very receptive minds for all that affects the great industries. Another cause for interest is the increasing importance of Wall Street in the money markets of the world. The personality of our President also is engaging the attention of all Europe. And still another cause of Germany's interest in our country, comes from the Emperor himself. Quite aside from the value of Prince Heinrich's visit, and the annual social amenities of the Kiel yachting week, in which American millionaires figure prominently, Kaiser Wilhelm is kept informed constantly by his own "Captains of Industry" gathered about the round table with their cigars. The German Emperor is tireless in educating himself. He is catholic in tastes, generous in encouraging those of his people who "do things," and full of initiative toward improvement

The Emperor's intimate acquaintance with the industries, kept up in parallel with his necessarily heavy burden of fiscal military, and naval detail, is a matter of every-day satisfaction to the Germans.*

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* "Strangely the old and new are combined in Kaiser Wilhelm; the romantic and the modern. Yesterday he was exhibiting inflexible absolutism; today he shows a deep understanding for the demands and the needs of the time."—*Tageblatt* editorial on Emperor's speech at opening of Danzig Technical University.

His creation of the degree of Doctor-Engineer was the official recognition that technics have become an essential element of modern culture. This raising of the technical profession to an equality with the other officially approved professions, in a country still hampered by bureaucracy, was an act of no little significance. Appreciating at once the marvellous rise of America's power, William II has insisted vehemently in all directions upon a more careful study of American "equipment." The visit to the United States of his Minister of Finance, accompanied by the proprietor of a steel works, was symptomatic of the Emperor's anxiety to have his best men acquainted with us. It has been followed by hundreds of other visits.

Mr. Frank Vanderlip, in 1901, published a series of articles entitled "America's Commercial Invasion of Europe." In New York a reprint fell into the hands of Count Tiele-Winckler, a favorite of the Emperor and owner of large mining and industrial properties. Upon his return home he showed the articles to His Majesty, and also caused them to be translated into German and privately printed. The Vanderlip "brochure" is responsible for not a little awakening and self-examination in German speaking Europe.

The mass of the people, in Germany at least, influenced by extravagant and misleading notices in their newspapers, still think of us as "The Dollar Land," the country of freaks and plutocracy. We have not as yet had time to impress Europe with the quality of our intellectual contingent. Our colleges and churches, our libraries and our literature, have excited little attention abroad. We are to Europe first of all intensely practical. Our wealth seems still to be our distinguishing characteristic among the nations. It is truly paradoxical that the German people, themselves famous for commercial attainments, should think of us only as money makers. Wealthy Americans are in fact more public-spirited in the use of their money than Europeans. On neither side of the Atlantic do the real leaders of finance and industry seem to be impelled alone by the love of money. The automatic increase of responsibility which comes with accruing profits, the pride of business and social position, the *noblesse oblige* of *haute finance,* are often the real motive where avarice alone is assumed.

Most visitors flatter us. All unite in admiring the energy and courage which were necessary for such unparalleled development as ours. Quantity, massiveness, volume, in manufacture and movement, surpass even their expectations. They overlook incompleteness of means in admiring the completeness of results; they are overcome by the elemental force, the surge and thunder of our traffic. The long lines of coal trains on multi-track railroads; the immensity of our farms; the mammoth conceptions in the building art which have given our cities their new physiognomy; our luxurious living; our clubs, hotels, limited trains—all are intensely interesting to them as indicative of, and suited to, conditions which do not pertain in Europe. The generally amiable personality of our people, and cordial frank manner of our business men, seem to be highly appreciated by our guests. The hospitality of our countrymen is praised by them long after they return to Europe. They are astounded at the liberality of our wealthy men in their contributions to public institutions; and some Germans have seen in this load of responsibility for the American millionaire an onus fully equivalent to the high taxes which he would have to pay in Europe. They laud the freedom from enviousness here, which, contrary to European conditions, allows a fuller co-operation of all our economic forces working to one end. Beneath the turbulence of our noisy life, some of our guests find also opportunity to recognize that strong under-current of refinement, broad intellectuality, and keen sense of artistic appreciation which the old countries still claim as their own monopoly.

The German opinion of our financial conditions can be characterized best, perhaps, by the answer of a leading Berlin capitalist, a pioneer in the appreciation of American methods, who was recently offered a participation in an enterprise in this country. He courteously refused it on the ground that American business conditions were at present too *undurchsichtig* (too un-see-through-able). Even those who admire so many American *individuals* and respect the solidity and absolute integrity of so many of our industrial and financial institutions, distrust our methods. They do not confine their distrust to Wall Street; to any great corporations or banks; on the contrary, they know that much of the loss and suffering and disorder has been brought about by careless management of small enterprises, and by small, unscrupulous, *unwatched* promoters close to the people, everywhere throughout the country. . The power of the individual in business, which is decidedly more of an American characteristic than European, becomes in their eyes dangerous because uncontrolled. The Germans would see us establish a business organization which shall be uncompromising where individual ethics may be weak and indefinite; something which shall be more continuously restraining, and less impulsively corrective, than popular indignation finding expression in the press. Germans can never quite overcome their surprise that the legal interpretation of what is right and wrong should so vary in our different States. They deplore our tendency to evade good laws where we have them. United Germany, being made up of States whose traditions were all very deeply rooted, could not easily bring about a uniformity in these matters; but technical and artificial barriers had to go down before the wise recognition that commercial solidity must rest on one rule for all, especially in matters pertaining to business. It is a matter of eminent significance that as long ago as 1848, when the German States were much less intimately bound together than they are today, a uniform law was adopted covering the subject of bills of exchange, and is in force today. In 1861 the business law, essentially as it is today, was also adopted uniformly by all the German States. Both of these laws are also the same in Austria. In 1870 a uniform criminal law, in 1879 a uniform law of court procedure, and in 1900 the admirable Civil Code, came into effect for all the German Empire.

While deploring our present faults, some German financiers look with envy upon the broad interest which the American public take in Stock Exchange transactions, thereby making the New York market so receptive and so able to meet the enormous demands which the development of the industries and railroads has put upon it. In Germany the Government supervision of the Stock Exchange is too rigid, and the stamp taxes on transfers of property are also a serious hindrance to business. In attempting to make popular speculation difficult, they drove away business from Germany to foreign markets. The Government interference has not seemed to be as helpful in this respect as it has in other departments of business.

German criticism is not unfavorable to our trusts. The consolidation of banks and industrial concerns is proceeding steadily in Germany as well as here. They have themselves over three-hundred trusts, "cartels" and "syndicates" (forms of combination for sale of product, or fixing of prices, and regulating of production). They recognize that trusts bring danger and that these dangers would be materially lessened if we had good and uniform corporation laws. A fundamental difference between the trusts in Germany and those in the United States is that owing to enforced publication of statements on the part of all share companies in Germany, it is always possible for the public to approximate closely the value of a trust's real assets, as separated from the profits taken by promoters. This means the publication of the balance-sheet with enough additional information to afford the stockholders (that is, anyone, as shares are not registered) a just estimate of the value of *their own* property.

It does *not* mean the divulging of business secrets, nor the dealing out of personal gossip to a curious and indiscriminating public. A great deal of healthful probing goes on in Germany continually, and behind closed doors. The guardians of the common weal are not expected to function *coram publico.* Germans laugh at us for hanging our affairs onto the "great bell."

As to the various specialists who come to the United States, theirs is the study of details by methods of strict comparison. There are many bases for such comparison, confined largely to American industries and methods of transportation. There are vast enterprises in Germany, quite comparable to our own, which render such comparisons extremely valuable for both countries. The electric railways in Berlin alone, for instance, carried 400,000,000 passengers last year. One German firm manufacturing electric apparatus and machinery has 30,000 employees on its pay roll. By far the highest speed ever attained on a railroad train has been made on a German track. Krupp's is only one of the great steel works. Some of Germany's 4,000 sea-going ships we all know.

The foreign engineers who study our plants recognize many points of superiority, but sometimes they find they are doing certain things as well as we are, or even better. American machinery and shop methods have been preached incessantly now for so long a time in Germany that many German shops do as good work as ours. In a country not so largely supplied with natural riches as the United States, they have applied themselves much more than we have to the increase of mechanical efficiency.

What must most impress one, however, from a consideration of all this inspecting of our works (and I want to testify to the fact that German visitors are very appreciative of our manufacturers' liberality in allowing their works to be seen) is that Germany does send a large number of men in all lines of work to study American conditions. Sometimes the leaders come themselves. Furthermore, they come really *to learn,* and not for vacations or to satisfy their pride. They are intensely objective. They come with the spirit of absorption, of getting either new methods to apply at home or at least a new impulse, a fresh excitation of the nerves of enterprise. We have, therefore, today, in the Kaiser's realm, the spectacle of a nation wisely afraid and quietly strengthening itself for the coming greater struggle. As the Emperor said, "Germany's future lies on the water." So, too, does that of our industrial East. Nations, like men, in growing strong are bound to reach out and expose themselves to new responsibilities.

Imperialism is not a question of policy for either Germany or ourselves. It is the concomitant of efficiency and virility. The Germans, seeing, therefore, what is before them, seem to understand far better than we do the great advantage of learning where and what they can. The Americans, on the contrary, are as a nation likely to be self-satisfied. An important German financier in recounting his American experiences to colleagues at home referred to our national love of praise. He also said: "Although I have been for years in business connection with America and come frequently into personal contact with American business friends visiting Berlin, I found that I had an entirely false idea of the land and people on the other side of the ocean. I can add, that I was quite as much surprised to find so inadequate a knowledge of our land and its inhabitants. In fact, *they seem to know less of us than we do of them.*"

Some of us not knowing the good to be found in other lands have no basis for comparison. Some of us know and do not care. We are, in some respects, afflicted with the spirit of *laisser aller.* We insist on having the best homes, full of comforts; but as soon as we close our doors behind us and pass to the street, a harsh change has taken place. We look with complacency on the public dirt, the unsightliness which is no individual's to alter, and the frequent inadequateness of what is supposed to serve the common good. As a people, we seem content to exercise our business acumen, frugality, and powers of organization in everything *but* public matters. We do not begin to live up to the high degree of technical and scientific enlightenment vouchsafed us in matters pertaining to public health or the avoidance of dangers.

The foreign visitor finds in the United States, as he expects to, refinements and luxuries on a scale to which he is unaccustomed. He is, therefore, the more surprised to find the clever, wealthy Americans putting up patiently with conditions which western Europe now considers antiquated. The disorder of street traffic; the nuisances and obstructions which are allowed to gather; the sweepings and refuse blowing about from coverless refuse carts; the dry sweeping of the streets; the accumulation of snow; the miserably inadequate gas lighting of some of our best residence streets just off the main avenue; the cab without a taxameter; the insufficiency of the police; the prevalence of crime; the lack of discipline so often apparent; the crying frequency of railway accidents—these features always surprise our guests. Fortunately we are beginning to understand that we have much that requires vigorous overhauling. Our President, too, has been doing what the public conscience without strong leadership might not have done for years to come. In the changes which are before use we are coming to exactly the same problems which the older countries have had to work out. Day after day our public men are proposing methods for which we might as well have the details from Europe, for most of them have been tried there.

In attacking every new problem and discussing every new proposal we are likely to find most valuable experience awaiting us on the other side of the ocean, if we will only ask for it. We could learn much from abroad in road building, municipal engineering, the improved handling of passengers' luggage, safety and hygiene in railroad and steamer travel, cab service, the inspection of buildings and ships, custom-house methods, forestry, trade schools, corporation laws, the registration and control of servants, workingmen's insurance and pension, safety and cleanliness in factories, export business methods, and scores of other particulars.

In various branches of our public service we can point to individuals who are of unquestionable integrity and equal, if not superior, intellectually, to their European *confrères*. These *individuals*, however, seem to lack the backing of an interlocking *organization*. Their good ideas are taken or refused by a public which has neither the training nor opportunity to learn in detail what is best for its own interests. The Germans have secured a certain degree of permanency for those offices where specific experience is absolutely necessary for guarding the people's interests. German mayors are mayors by profession. They begin in small towns and are called to large cities if they distinguish themselves. They gather experience and ultimately master the problems of municipal administration. Not only the mayors, but the aldermen who supervise such specialties as the care of orphans, poor and insane, and matters pertaining to public health, hospitals, etc., have long careers in which they amass and wield valuable knowledge for the public good. The city engineers are practically sure of permanent positions if they are masters of their work They are given every opportunity to study the works of other cities and even allowed to advise on similar work in foreign countries. The city engineer of Berlin has just presented plans for extensive warehouses and tunnel work, but before preparing these plans he visited dozens of warehouses, grain elevators, inland harbors, and all the subways in the United States, England and France.

If they have few destructive fires and few unhealthful districts or unsafe buildings, few disfigured streets and burglaries, it is not because the German *individual* is so careful, reasonable or good, but simply because he must subordinate himself to the distates of a *mighty, and permanently incorporated, sense of public guardianship.*

Many of our good citizens delay reform by deprecating any word of criticism. They constantly assure us that we will work out our own salvation by a natural process of development. In *business,* however, we do not wait for natural development. There we compel results; we reject and select until the product and the methods are beyond criticism. Why not apply the same attitude of thought in all things regarding which we are open to criticism, from our own, as well as foreign, observers?

Every wideawake American who has anything to manage, from a machine shop up to a Department of State, may improve his results by making it a part of his duty to know how the same work is done among other successful peoples.

Supplied as we are with the Earth's riches, free in action, and with blessed traditions to guide us, we cannot afford to neglect our competitor's strong points. It requires eternal vigilance and self-recognition really to become what we are not yet, an American Danger.

We may all say with mediæval Gerard:

> "This then have I, Sir Footsore, learned, that each Nation hath its proper wisdom, and its proper folly, and methinks could a great king, or duke, tramp like me and see with his own eyes, he might pick the flowers and eschew the weeds of Nations."

AUSTRALIAN COAL PILED NEAR MAGELLAN'S MONUMENT, SOUTH SIDE OF THE PASIG RIVER.

The view is just outside of the "walled city," Manila, and shows coasting steamers and quartermaster's launches in the river.

UNITED STATES ENTERPRISE IN THE COAL TRADE OF THE PHILIPPINES.

By Oscar Halvorsen Reinholt.

Mr. Reinholt was Superintendent in Charge of Exploration, U. S. Government coal mines, Albay province, Philippine Islands, in 1903 and 1904. He was in direct charge, therefore, of the developments described in the following pages. His definition of the possible economic importance of the deposits is clearly put in his introduction, and needs no restatement. The photographs from which the illustrations are reproduced, with the exception of two small views specially credited on pages 507 and 511 were taken by the author.—The Editors.

NOTWITHSTANDING all the public interest displayed in proposed Government ownership, or control, of certain materials and services, little or nothing has yet been published in the United States about the first attempt of the Federal Government to develop a source of fuel supply for a part, if not all, of its own demands. That attempt began in earnest thirty months ago, when First-Lieutenant Hubert L. Wigmore, aide-de-camp to General Davis, was placed in charge of this important undertaking by the Secretary of War, and the writer, a civilian mining engineer, was detailed by Governor Taft to assist the above named officer of the Corps of Engineers. The site selected was in the Philippines where, fortunately, the economic conditions are very favorable, inasmuch as nothing in the shape of a private coal-mining industry is there established to antagonize.

Uncle Sam is not, however, the first among nations to initiate so important a step. The Governments of at least two British colonies have for several years made serious efforts to supply themselves with mineral fuel from their domestic deposits. Since 1901, Cape Colony* has been trying to purchase, or to find and develop, a coal mine primarily for the needs of the Government railroads. New Zealand,† long noted for the application of advanced theories in political economy, has now succeeded in opening two coal mines, avowedly to make the colonial railways independent of private production of fuel, and to regulate prices of coal by unloading the surplus product upon the market whenever desired.

For some years past the government of the Dutch East Indies,‡ famous for the "culture" system of raising revenue, has met a large part of its requirements in coal through the operation of state collieries on the island of Borneo.§ The Servian State Railway now actually controls about half the output of mineral fuel in that little European country. Even in conservative Germany, the Governments have their eyes open to the advantages gained by possessing coal properties of their own, especially where the railroads are under the ownership or direct management of the state. Thus the Kingdom of Prussia recently made overtures to the Westphalian Syndicate, though without success, for the acquisition of collieries in the great Ruhr coalfield from which the State railways might obtain the necessary combustible. The instances cited are all of Government enterprises in the old world, and they well imply the intimate relation of coal mines to steam railways.

On the American continent there are, to my knowledge, only two countries whose governments have decided to embark in the business of coal-mining. They are Venezuela and the United States of Colombia, both of which bear some natural resemblances to the Philippines, not the least important being the possession of unexploited mineral resources, particularly coal and lignite.

The coal consumption of the Philippines is as yet relatively insig-

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* "Report on the Mining Industry of Natal for 1902," pages 16, 17 and 73.

† "Papers and Reports Relating to Minerals and Mining in New Zealand," 1904, and *The Engineering and Mining Journal* of October 27, 1904.

‡ "The Mineral Industry for 1903," published by *The Engineering and Mining Journal.*

§ "English Statesmen's Yearbook," 1904, page 115, states that the Rajah of Sarawak has a monopoly of coal mining in Brunei, British Borneo.

RAILWAY TRANSPORT IN THE PHILIPPINES. TRAIN ON THE MANILA-DAGUPAN LINE.

The railway—about 125 miles long—has been for many years the only steam road in the Islands. Its fuel consumption makes but a small percentage of the coal used in the Philippines.

nificant, owing chiefly to a warm climate, a small railway mileage, and a backward state of manufacturing industries. Although the total consumption has nearly quadrupled in the course of the past ten or twelve years, and now approximates 400,000 tons per annum, including all purchases of the War Department on account of the Philippines, the amount used per capita is still ridiculously small, averaging of late not much more than one-twentieth of a ton each year. Compared with the Philippines, Japan has a per-capita consumption of coal three times as great, Australia twenty-seven times, Belgium nearly sixty times, and the United States over eighty times as great. Even in South America, most of the countries surpass the Philippines in this respect. But in China, where the coal deposits are considered to be the most extensive in the world, the quantity of coal used per inhabitant is probably not one-tenth of that in the Philippines.

The coal consumed in the Philippines is practically all imported. It may be safely ventured that in no year hitherto has the local yield reached a record of 10,000 tons, and that may therefore be disregarded as a factor of importance at the present time. Coal is utilized in these islands almost entirely for steaming purposes, mainly on board vessels near Manila and in inter-island transportation. The Government, inclusive of the civil as well as the naval and military branches, disposed of 60 per cent of the imports in 1903, the United States Army alone taking 35 per cent. While the latter was formerly the leading consumer, it has now dropped to second place with the passing of active warfare from the islands.

In 1903 the general public consumed 40 per cent of the imports, compared with 35½ per cent in 1902 and hardly 30 per cent in 1901.

NATIVE TRANSPORTATION BY LAND IN THE PHILIPPINES.

A single *carabao* or water buffalo usually draws the *carretón*—rarely a team of two or three. The load in the picture is *abacá,* or Manila hemp—the chief product of southeastern Luzon and of the Visayan islands (Cebu, Leyte, Bohol, and Samar).

NATIVE WATER TRANSPORT. A BARROTE ON THE GULF OF ALBAY.

A "dugout," for minor use, is seen behind the fish corral. The outriggers of the *barrote* are made of bamboo.

MAYON VOLCANO, ALBAY PROVINCE, SOUTHEASTERN LUZON.
Height, 7,916 ft. While not the highest, it is probably the most frequently active of the twenty active vents reported in the Philippines. Dr. Becker says: "It is possibly the most symmetrically beautiful volcano cone in the world." "The vertical outline is the hyperbolic sine curve." View taken from Legaspi during high tide, by the author.

This increase was a natural consequence of peace conditions which have prevailed for more than four years. The United States Navy, which ranks as the third consumer, has depended quite exclusively upon the excellent Pocahontas steaming coal from West Virginia, to the extent of from 14 to 20 per cent of the annual imports during these three years. The Civil Government, while yet the least important, has increased its takings at the greatest rate of the four consumers.

TABLE OF IMPORTS OF COAL INTO THE PHILIPPINES, IN LONG TONS, ARRANGED ACCORDING TO THE SOURCES OF THE SAME, 1901-3.

Origin of Imports.	1901.	1902	1903.	Three Years.	Leading Consumer.
Japan	275.761	180,186	159.257	615,204	Army 81.7 per cent.
Australia	78,948	90,949	161,074	330,971	Public 86 " "
United States	59,179	70.514	72,156	201,849	Navy 94.5 " "
United Kingdom.	1,231	7,648	Nil	8,879	Public 100 " "
Germany	2,778	7	Nil	2,785	" 100 " "
British India	46	897	Nil	943	" 100 " "
China	218	29	129	376	" 100 " "
All others	499	406	432	1,337	" 100 " "
Total........	418,660	350,636	393,048	1,162,344	Army 44.2 " "

TABLE OF PERCENTAGES CONTRIBUTED BY THE TWO LEADING SOURCES OF COAL IMPORTED INTO THE PHILIPPINE ISLANDS.

	1901.	1902.	1903.	Three years.
Japan	05.9	51.5	40.5	52.9
Australia	18.9	26.0	41.0	28.5
Total.........	84.8	77.5	81.5	81.4

As regards the sources of the fuel, it appears that the Orient supplies nearly five-sixths, the other sixth originating almost entirely in the States. Very little of the American coal, however, is bought by other consumers than the Navy. The Oriental coal trade with the Philippines has so far been monopolized by two producers separated by a sailing distance of over 3,500 miles. These two, Japan and Australia, are the principal sources of coal mined on both borders of the great Pacific, and together control half the coal output of that drainage area. In coal-mining around the Pacific the only other regions worthy of note are, in appproximate order, Washington, New Zealand, British Columbia, North China, Mexico, and Chili. Their production ranges in round numbers from one million tons in Chili to three million tons in Washington, or in no case as much as one-third the production of Japan.

Australia, or rather New South Wales, to be more specific, has lately taken the leadership from Japan in supplying the coal market of the Philippines. While the War Department (the principal Philippine customer of the island empire, and the contractor here for Japanese coal only) has suffered a decrease in its requirements since the inaugural of civil Government, the latter and the private consumers, on the other hand, both favoring Australian coal, have experienced a rapid growth in their demands during that time.

The success of the Australian product in the Philippine market may be ascribed to its superior quality compared with the Japanese coal, combined with a gradual reduction in the price asked for the former. The Australian fuel, as delivered in Manila, is entirely bituminous coal of Permo-Carboniferous age, and its fixed carbon alone, on the average from 25 to 45 per cent above that in the Japanese coal, has a heating capacity generally exceeding 6,000 calories.* The coals from Japan are mostly bituminous, slightly lower in ash, and about equal in total heat units to the Australian fuel, but much richer than the latter in gaseous hydrocarbons. They are inclined to be lignitic and rather unclean, and are furthermore much younger, never found in beds of earlier age than the Mesozoic, but usually intercalated

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* The fixed carbon, i. e., carbon in the coke, must here be made the real basis of comparison between these coals, since the exports of both Japan and Australia are utilized almost entirely on steamers whose boilers, as a rule, are not adapted for obtaining the best results from fuels which, like the Japanese and Philippine, are relatively rich in volatile combustibles.

TAKASHIMA COLLIERY, EIGHT MILES FROM NAGASAKI, JAPAN.
One of the sources of Philippine coal supply. On this island of Taka, coal has been extracted from under the sea at a depth of 900 ft. Two shafts were being sunk within this coffer dam, outside the shore line, when the picture was taken. Mr. Tsumaki, chief mining engineer, is standing in the center.

between Tertiary strata. The typical Japanese coals of commerce differ chiefly in the amount of moisture present from the better grades of Philippine black lignites of similar age, which here and there actually grade into true bituminous coal. In the former the water content is generally less than 5 per cent, but in the latter it occasionally runs as high as 20 per cent.

To compensate for this decided advantage in the quality of their coal, the Australian producers have been severely handicapped by greater costs of mining as well as higher rates of transportation. Although the colliery operators of New South Wales have materially reduced the cost of coal* at the pit mouth during the past twenty

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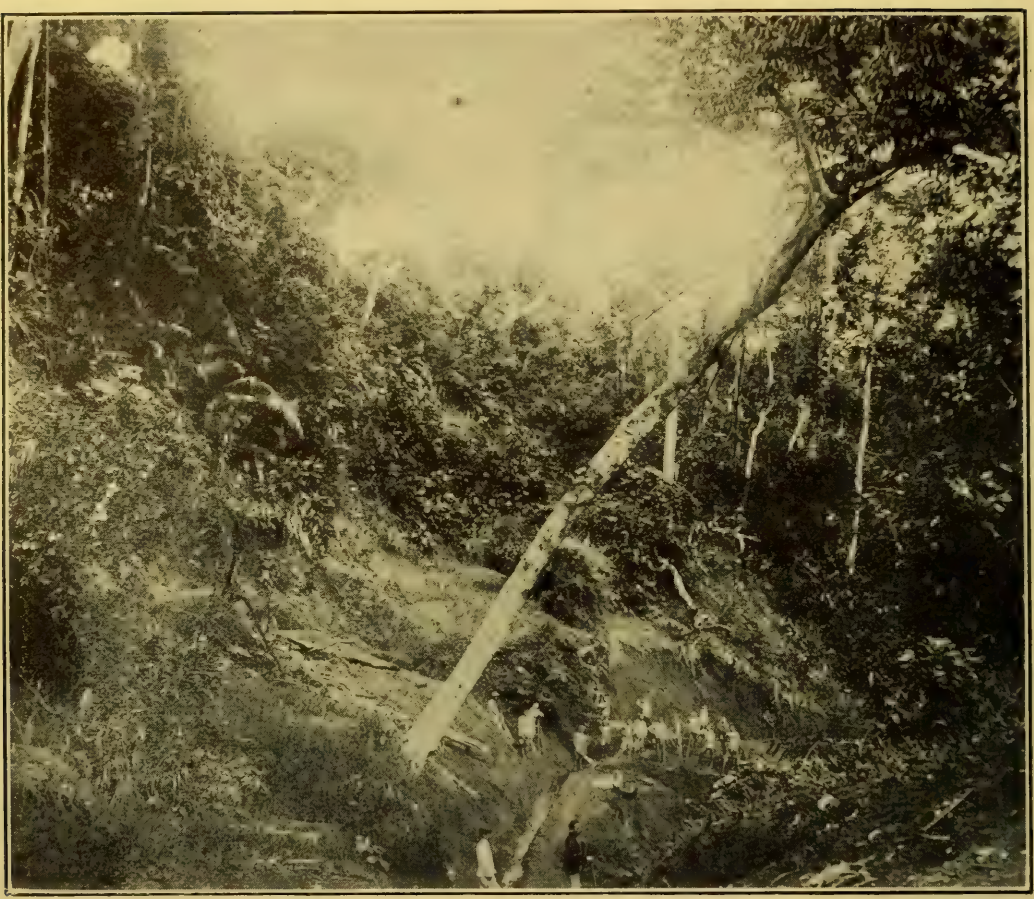
* A few years ago the average cost of producing coal per long ton was $1.22 in Japan compared with $1.40 in New South Wales. At the same time it was only $1.15 in the United States where coal-mining machinery is so extensively employed. During the fifteen years ended in 1898, the mine managers in New South Wales had succeeded in cutting down the expense of placing their coal at the pit mouth from $2.31 to $1.33. More recently that cost has risen, from $1.48 in 1900 ($1.01 in the United States) to $1.80 in 1902 ($1.09 in the United States). See "Commercial Japan in 1904" and "The World's Coal Supply and Trade," monographs of the Bureau of Statistics, Hon. Oscar P. Austin, chief; also "Mineral Resources of the United States," 1903, and "A Statistical Account of Australia and New Zealand," 1902-1903, by T. A. Coghlan.



TYPICAL VIEW OF FOREST AND JUNGLE, BATAN ISLAND.
Taken near the Bilbao Mines, east of the reservation. Japanese are working on the trail.

years, the Japanese mining companies can still produce the fuel at an outlay considerably less, owing above all to the lower wages paid in the "Land of the Rising Sun."

While distance is not the only element determining transportation charges, it is, nevertheless, the principal one in this particular case of competition between Japan and Australia. The great port in the coal trade of Australia, namely Newcastle in New South Wales, is removed, by the shorter water route, about three times as far from Manila* as are Moji and Nagasaki, the principal ports of Japan in its coal trade with the Philippines. This geographical advantage of Japan is altogether of far greater significance than the economic one of production, especially when it is considered that a very large part of the purchases of Japanese coal made by the War Department of the United States is delivered directly to transports calling conveniently at Nagasaki *en route* to or from the Philippines.

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* Fully nine-tenths of all the coal that is brought to the Philippines is delivered at Manila, Marivales, and Cavite, the two last named being well-known coaling stations on Manila Bay.

Thus it is that in discussing the prospects of the United States Federal Government[*] supplying itself from native sources with the mineral fuel needed in the Philippines, an absorbing question of dollars and cents will arise. Can the Government mine Philippine coal (i. e., coal equivalent to the average fuel furnished by Japan) and deliver the same at suitable coaling centers at a cost at least as low as the Philippine prices of Japanese coal?

TABLE SHOWING PRICES OF COAL PURCHASED BY THE U. S. WAR DEPARTMENT ON ACCOUNT OF THE PHILIPPINES.[†]

Year.	Source.	Description.	Tonnage.	Price.	Place of delivery.
1901	Japan	All delivered at Manila.	87,361	$7.78 a	Manila.
1901	do.	do. do. Nagasaki	142,900	3.26 a	Nagasaki.
1901	do.	Komatsu (Kyushu I.). .	62,185	3.19 s	do.
1901	do.	Yoshinotani do. . .	40,544	3.33 s	do.
1902	do.	All delivered at Nagasaki	49,831	3.66 a	do.
1902	do.	Miiki (Kyushu Island).	24,476	3.30 s	do.
1902	do.	do. do. do. .	60,482	5.65 s	Manila.
1902	Australia	Duckinfeld (N. S. W.)	3,682	9.00 s	do.
1902	Japan	Tagawa (Kyushu Island)	9,125	7.00 s	Iloilo and Manila.
1902	do.	Mutabe do. do.	21,022	4.00 s	Nagasaki.
1903	do.	do. do. do.	31,364	4.00 s	do.
1903	do.	Kishima do. do.	50,230	5.38 s	Manila.
1903	do.	Yoshinotani do.	30,199	5.23 s	do.
1903	do.	do. do. do.	6,634	6.75 s	Zamboanga.
1903	do.	All del'd at Nagasaki...	49,210	4.00 a	Nagasaki.
1901-3	do.	do. do. do. do. (3 yrs.)	241,941	3.49 a	do.
1903	do.	Miiki (Kyushu Island).	12,123	3.70 s	do.
1905	do.	do. do. do. .	?	3.00 s	do.
1904	do.	?	?	4.80 s	Manila.
1901-3	do.	All Philippine deliveries.	244,031	6.38 a	Philippines.

The above table shows that the prices of Japanese coal delivered at Manila to the War Department from 1901 to 1904 fell but once below $5.00, and that the average of that delivered from 1901 to 1903 exceeded $6.00. For the immediate purpose of this article the minimum Manila price to the military branch of the United States Government will be taken, in round numbers, at $5.00, an amount much less than the open-market price of Japanese coal, which, in turn, is generally one dollar lower than that of the Australian product.

Let it be assumed, in the present discussion, that coal can be mined in quantity in the Philippines at a cost of $2.00[‡] per ton which is fully 25 per cent above the average cost of Japanese coal at the pit mouth, a very liberal allowance. Let $1.00, a very reasonable estimate, be allowed for the expense of placing it on board Army transports or other vessels, including thereunder the cost of a short railway haul. That would make a maximum total of $3.00, the same as the contract price in 1905 for Japanese coal f. o. b. transports or colliers at Nagasaki, and about $2.00 below the minimum price paid by the Army for the latter at Manila. As the deliveries at Manila have approached the hundred thousand mark in recent years, the total saving which might be annually effected by the War Department alone, through the insular production of all this coal, would approximate not less than $200,000; surely no mean amount!

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[*] That is, the Army; since the Navy, the only other direct representative of the Federal Government, upholds too high a standard for the use of Philippine coal.

[†] The data here given are all for fiscal years ended June 30. The quantities indicated are in long tons and the prices in United States currency, "a" being average price and "s" specific or contract price. The entire table has been compiled from information furnished by the Quartermaster's Department, U. S. A., Manila.

[‡] The average cost of mining bituminous coal in the United States is usually not much more than $1.00 per ton.

While the prospect of losing annual sales of a hundred thousand tons (or even a little more if the Nagasaki deliveries be also cut off) may be disheartening to certain Japanese coal dealers, particularly the Mitsui Bussan Kaisha, such a loss would really signify but little in Japan's entire export trade in mineral fuel. In 1902 only 4.4 per cent of the foreign-bound coal shipments* went to the Philippines compared with 1.9 per cent to the Dutch East Indies, 14 per cent to the Straits Settlements (mainly to Singapore), 31 per cent to Hongkong, and more than 44 per cent to China. If such possible decrease should be limited to Manila deliveries to the Army, the per cent loss to Japan's total export trade would be less than 1.0 instead of 4.4.

Doubtlessly it was the fear of colliers from foreign countries being intercepted in time of war—thus a matter of necessity rather than of mere economy—that led the late Secretary of War, Mr. Root, to instigate inquiries concerning the possibility and practicability of supplying Philippine coaling stations with serviceable fuel taken from mines within the archipelago.

The pioneer, indirectly, in this work of investigation for the American government, was Dr. George F. Becker† of the United States Geological Survey. He served as geologist for the Military Government in 1898, and in connection with his general geological studies personally visited a few coal prospects on Cebu and Negros, but owing to the disturbances and attendant dangers at the time, he could not make extensive observations.

Hon. Chas. H. Burritt, now a judge of the Court of First Instance in the Philippines, compiled a valuable report in 1901 when he was the army officer in charge of the Mining Bureau at Manila. In his history of coal discoveries and efforts at mining under the Spanish *régime,** Judge Burritt accounts for the delayed development of the coal resources largely on the grounds that the Government was actually antagonistic thereto. To his explanation must be added: unsystematic and insufficient explorations, poor financing, bad management, and scarcity of skilled labor. He enumerates three causes that "influenced the officers and employees of the Spanish government in their manifest opposition to the use of Philippine coals":—1. The prices paid for English coal used by the Spanish navy were so extravagant as to easily allow for the percolation of a large per cent into the pockets of the Spanish officials. 2. The custom of buying coal from England was well established and was very convenient to the Spanish purchasing agents and others who disliked change. 3. The engineers and chief machinists of the Spanish navy were largely Britons who regularly reported unfavorably on the use of other than British fuel.

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* In 1902 Japan sold to foreign countries 30% of her coal output, while England, whose coal exports exceed those of the rest of the world collectively, sold only 20% of her home product. In the same year New South Wales disposed of 55% of her yield to other colonies and foreign countries.

† One of the earliest reviews of his valuable study of the Philippines appeared in THE ENGINEERING MAGAZINE. His "Geology of the Philippines" contains eight pages on the coal resources.

Direct investigations, with the view of ultimately opening and operating Government coal mines, were inaugurated in 1901. That was just after the appearance of Judge Burritt's encouraging report, when the commanding general of the Philippines was advised that such was the desire of the Secretary of War. First-Lieutenant Edward M. Markham, corps of engineers, was appointed in September, 1901, to make a preliminary and general survey of the more promising localities where coal had been found. This officer submitted, late in March, 1902, a comprehensive report wherein the coal deposits on Batan island were recommended for future and more minute examination, in preference to the two other favorable occurrences observed, one in the province of Zamboanga in western Mindanao and one in Cebu, the province embracing the island of the same name.

The reasons advanced in favor of this small island, no larger than an ordinary American township, were threefold. 1. *High calorific power of merchantable coal.* The analysis of the seam supplying what was deemed the most marketable coal on Batan island indicated a higher fuel value than that of any coal seam examined elsewhere, although one sample from Zamboanga had a slightly greater percentage of fixed carbon. 2. *Ideal harbor near the outcrop of coal.* A deep-sea anchorage, well protected, approaches within half a mile of the nearest outcrop of the bed referred to, thus involving a minimum outlay for land transportation. 3. *Location near route of army trans-*

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* "The Coal Measures of the Philippines," Bureau of Insular Affairs. Pages 11-12 and 174-177 of this report deal with coal-mining on Batan Island.

ports. The position of Batan island* is not only quite central with respect to the Philippines as a whole, but is far superior to that of any other spot similarly adapted for a coaling station, inasmuch as the island is situated scarcely forty miles, or three hours of ordinary steaming, north-north-west from the course which army transports take in going from San Francisco to Manila via the neighboring strait of San Bernardino.

As a result of Lieutenant Markham's recommendations, the western three-fifths of the island was withdrawn from entry and made a temporary military reservation on July 1, 1902. A fund of $15,000† was made available February, 1903, for the exploitation of a limited portion of this area. Finally, in June, 1903, First-Lieutenant Hubert L. Wigmore, then on the staff of General Davis, was detailed in charge of the development work. This officer had previously distinguished himself through bravery in the Moro campaign. His map of Jolo was the first reliable one of that island to appear.

Lieutenant Wigmore arrived on Batan island early in July, 1903, bringing with him, besides a detachment of American soldiers, a force of about twenty-five Japanese, mostly miners. The introduction of this foreign labor was absolutely unavoidable. The climate, not to mention the high cost, militated against the employment of white labor; immigration laws forbade the entry of Chinese; while superstition and lack of skill were the obstacles in the way of working the native Filipinos underground. In justice to the natives, both Tagalogs brought down from Manila, and Bicols living in the vicinity, it must be said that, considering all their conditions of life, they gave good satisfaction as unskilled surface workmen or even as timbermen and carpenters. It was rather remarkable how many of them actually reported for work on some *fiesta* days. Altogether up to fifty Filipinos were carried on the pay-rolls at times, which, with the Japanese enlisted men, and the few civilians, made the total number of persons employed at the Government Coal Mines seldom as many as one hundred.

Mr. Wigmore, as the executive head of the enterprise, was exceedingly energetic, very conscientious, and quite capable for his task. He personally supervised all the construction work. That included the

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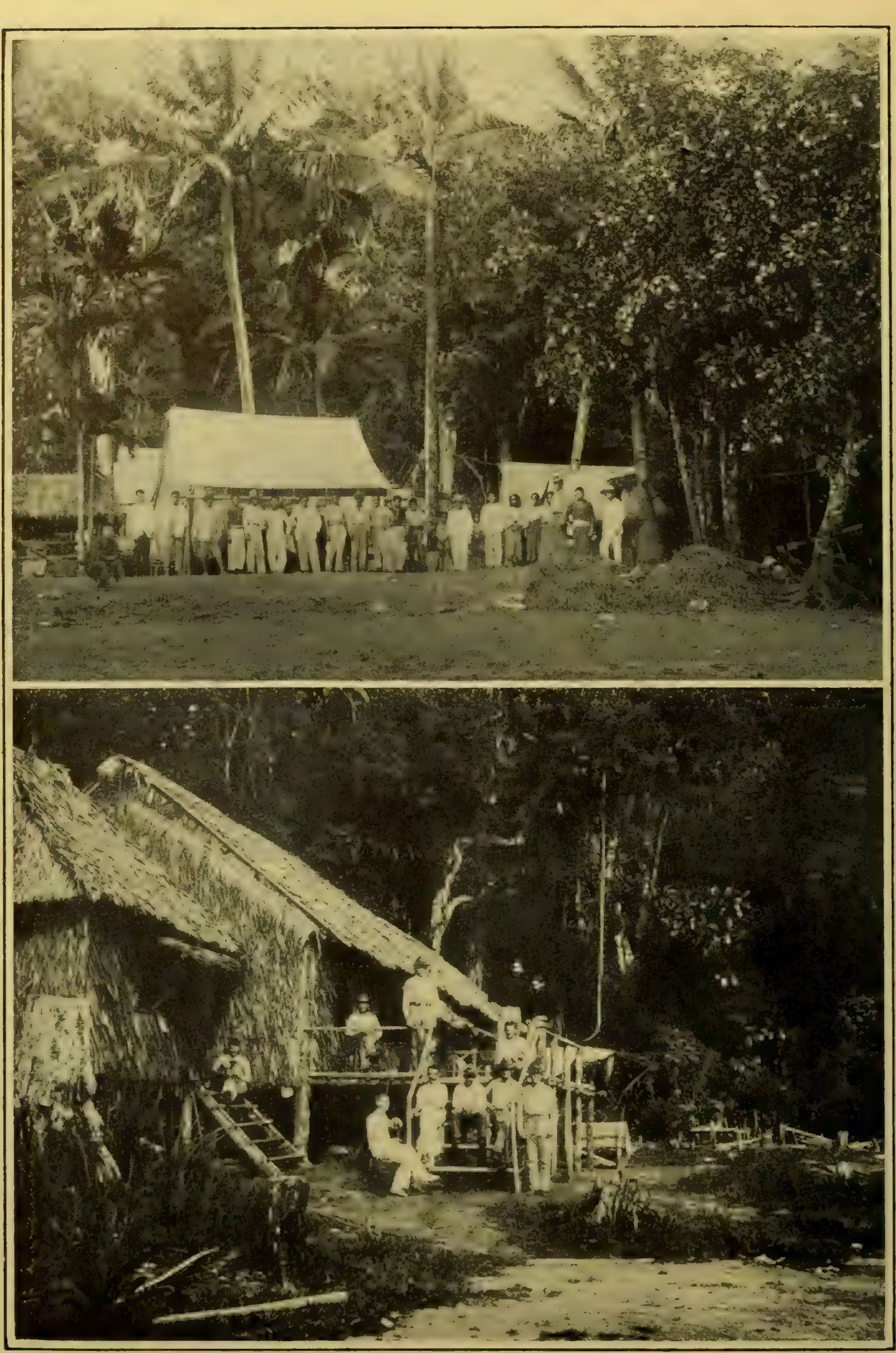
* The dock built on Coal Harbor, near the western extremity of the island, lies in latitude 13° 16′ 0″ north and in longitude 123° 54′ 07″ east of Greenwich. From Manila, Batan is distant about 400 miles by route of steamers, and in an airline only 230 miles S. 65° E. It is 570 miles from the northernmost islands of the archipelago, 650 miles from the southern most members, and only 80 miles east of the center of the boundaries of the Philippines delineated by the treaty with Spain in 1899.

† Subsequent allotments increased this successively to $32,000 and $90,000.

MESS TENT OF LIEUTENANT WIGMORE AND MR. REINHOLT, SEPT.-DEC., 1903.

building of a small stone dock, and, under great difficulties, the building of a narrow-gauge incline one-fourth mile long; the erection of an office and ware-house on the dock, and of permanent quarters elsewhere for the officials and employees; also the impounding of potable water for use during the dry season. The mining of large lots of coal for experimental purposes and local use of the government was entrusted largely to competent Japanese foremen, the miners working first on a wage basis and later on contract. Most of the topographic surveys of the reservation as well as the soundings in the harbor were executed by members of the corps of engineers, directed by Lieutenant Wigmore.

I landed on the island two months later than the commanding officer. My duties as superintendent of exploration comprised the making of reconnaissance surveys, both geologic and topographic, and the sampling and analysis of the fuel deposits. But it was more particularly the supervision of the diamond drilling that engaged my attention and for which my services as a mining engineer were loaned by the civil government to the military authorities. That work of drilling, representing the *first scientific* or *systematic prospecting con-*



RESIDENCE QUARTERS, GOVERNMENT COAL MINES, BATAN ISLAND.

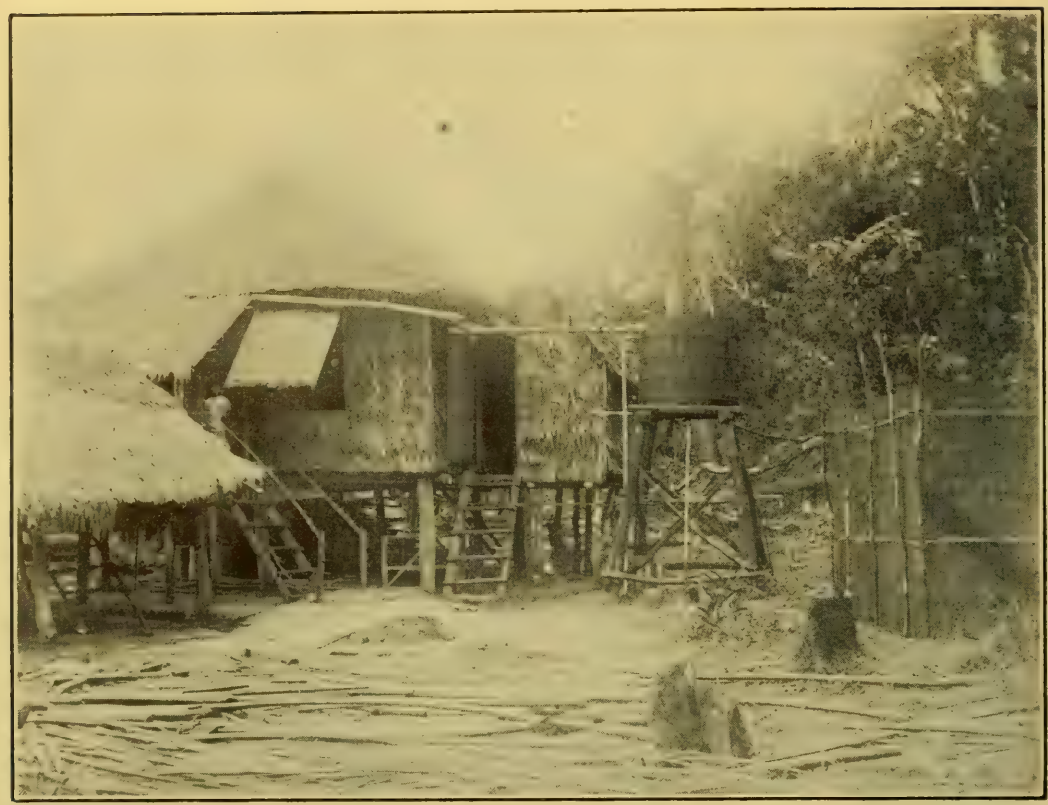
The upper view shows the quarters of non-resident native employees; the lower, the barracks for the enlisted men.

ducted in the Philippines, was begun in September, 1903, and carried on, with minor interruptions, until May, 1905.

THE FIRST PROSPECT HOLE IN THE PHILIPPINES BORED WITH A DIAMOND DRILL. GOVERNMENT COAL MINES, BATAN ISLAND, OCT., 1903.

The Bravo machine (Sullivan Machinery Co.) was used. Diameter of hole, 1 9/16; of core, 15/16; total depth, 101 ft., the lower 14 ft. being in fissured or cavernous limestone. A single bit, set with carbons by the superintendent, did the work.

Additional drills and an expert drill foreman from the States reached the Government Coal Mines in July, 1904. By the more extensive drilling for which these provided, as well as the more intensive operations permitted by means of continuous eight-hour shifts, a very large amount of exploring was done in the ensuing ten months. The foreman, whose name was Gustav Carlson, and who had served with me in a similar capacity back in the States, assumed charge of the actual drilling upon my departure. A great deal of credit is due this man for accomplishing so much as he did in spite of discouraging conditions familiar to all engineers who have lived and struggled any length of time in the tropics. Altogether, nearly 6,000 feet of shallow drill holes were bored at twenty-three separate points within an area of less than a square mile on the reservation near Coal Harbor. Gasoline engines were utilized for much of the motive power; nevertheless it was the hand-power of natives running the "Bravo" machine that bored the deepest hole, yielding cores 1⅜ inches in diameter to a vertical depth of 350 feet below the surface.



TEMPORARY QUARTERS OF OFFICIALS, JANUARY-MARCH, 1904.
The hut is built largely of bamboo and thatched with *nipa* palm leaves. The elevation on posts, to permit air circulation between the floor and the damp ground, is characteristic of the native huts.

Batan island, which has been the scene of all the above activity, is the largest of a chain of four islands jutting out into the Pacific on the north side of Albay gulf, southeastern Luzon. It has an extreme width of nearly five miles and a length of about fourteen miles. Like its neighbors, it is quite mountainous, the limestone peaks in some parts rising 1,000 feet and more above sea-level. Its outline is rather irregular, two large bays indenting the north shore and two minor ones the south shore. The island is surrounded on all sides with fringing coral reefs, a menace to navigation in some places.

The climate of this locality is warm, wet, and oceanic, like the prevailing climate of the Philippines. The temperature is remarkably uniform; the daily extremes noted in several months while I was volunteer observer for the Philippine Weather Bureau, were 74 degrees F. at 6 a. m. and 91 degrees at 3 p. m. The heat, however, is more oppressive than these figures would imply, since the atmosphere throughout the year is so highly saturated. The rainfall, accurately registered for fifteen months, does not differ essentially from that of Legaspi, the hemp port which is situated sixteen miles to the west and which ranks among the more humid stations in the archipelago. Over 100 inches of rain have fallen there in single years. Fortunately for engineering undertakings, such as mine pumping, the precipitation here during normal years is more evenly distributed than in many other places in the islands, and yet some days and even months have witnessed a phenomenal downpour. For instance, once during April, 1904, over 7 inches came down in 24 hours, and during the whole month of December, 1903, when there were only three clear days but much typhoon weather, a rain-fall of more than 35 inches was recorded.

In consequence of the climatic relations the plant life is extensive, dense, and varied. Fully three-fourths of the area is wooded, or proportionately a little more than the average throughout the archipelago. The only noteworthy barren ground covers hills of serpentine, soil from which is anywhere unfavorable. There are present on the island many of the 900 species of Philippine hardwoods, most of which are heavy and a few quite large. Some of the trees are the equivalent of Central American mahoganies, but only a few of them are well adapted for mine timbers. Besides trees may be seen bamboo, tree-ferns, lianas, palms, and other tropical plants, including beautiful orchids. Monkeys, deer, wild hogs, a few snakes, enormous tree-bats, a large species of lizard, and some peculiar birds, such as the red-billed *calao* which emits a horrible cry, are the larger denizens of the deep forests. Scorpions and centipedes abound as the arthropods of unpleasant reputation. Among insects, the white ants, notorious

Photo by Deberri.

A SPANISH BUNGALOW, HEADQUARTERS OF THE COMMANDING OFFICER AND SUPERINTENDENT OF EXPLORATIONS, BATAN ISLAND.

FOREST ALONG THE GOVERNMENT RAILWAY, BATAN ISLAND.

The air plants and lianas are here particularly prominent. A Japanese, standing at the foot of the largest tree, gives an approximate idea of its height.

as wood-destroyers, are worthy of mention as having once caused a wreck on the trestle of the railway. It is an interesting fact that mosquitos are not annoying on Batan island, but the leeches make their mark instead, especially when the vegetation is damp. The human inhabitants, belonging to the tribe of Bicols, number over 2,000, and are concentrated in villages along the coast. They are engaged principally in fishing and in the production of *abacá* or Manila hemp. As a matter of curiosity, I have observed in the interior a couple of specimens of the Aetas or Negritos, remnants of the pygmy autochthones of the Philippines.

About one-eighth of the area of Batan island is of volcanic origin. Nearly all of this part consists of a continuous ridge of serpentine, rising 600 feet above sea-level and extending along the north shore five miles from the northeastern point of the island. Apparently the same altered rock is exposed in two limited spots on the south shore, separated from each other over four miles.

With these exceptions the surface formations of the island appear to be entirely sedimentary. The stratified rocks, embracing an upper and a lower limestone with the coal measures interbedded, seem to lie unconformably against the basic eruptive above referred to. The upper limestone appears to be at least 700-feet thick, and the coal measures fully 300 feet. Wherever limestones occur there the Karst phenomenon of roofless caves has been extensively developed. Large and beautiful terraces of tufa have been built near the base of the limestone elevations. Faults and folds are not uncommon, but their extent has not yet been fully determined. The strata are horizontal

THE EFFECTS OF TROPICAL RAINFALL. LANDSLIDE AT THE URGERA ANTICLINE.

in only a few places and dip elsewhere as high as 58 degrees.*

The sedimentary series belongs unquestionably to the Tertiary period. Professor Mayer of Zürich, Switzerland and Doctor Dall of our Smithsonian Institution, agree, from the examination of fossils collected and personally submitted by me, that the upper limestone should be referred to the Oligocene epoch.† Doctor Dall concludes that the coal is probably Eocene. As regards the age of the igneous rocks, the most that may be said with certainty is that they date from pre-Tertiary times.

HAULING COAL ON SLEDS FROM THE SAN FRANCISCO MINE TO THE HEAD OF THE URGERA RAILWAY.
By means of greased runners and slats across the trail, the Japanese workmen guided sled loads of 1,200 lb. down grade half a mile. The view is taken in a grove of cocoa-palms and hemp palms, the latter belonging to the banana family.

The coal measures are made up of alternating beds of shales, sandstones, clays, and black lignite or lignito-bituminous coal, besides a few small bands of limestone in their lower horizon. As many as five different beds of fuel have been distinguished. These measures increase in thickness, but apparently grow more and more barren of coal towards the north shore, where along Gaba bay, the sandstones and shales of the upper portion of the measures may be regarded as trachyte tuffs slowly deposited in water. A little southwest of Calanaga bay, the eastern one of the two major indentations on the north shore, a Spanish company has operated within the past ten years, first mining coal by means of expensive Spanish labor and later (1903-4) with the help of Japanese. Here the maximum thickness of coal seams examined is about five feet; but near the south shore, towards the western end of the island, twenty feet of coal was penetrated by a drill; and at the apex of the anticline on the Urgera *pertenencia** there is an abnormal accumulation of over 30 feet of mineral fuel. However, the greatest *normal* thickness of any seam on the island, measured at the surface by me, did not exceed 8 feet.

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* Faulting is no doubt still in progress, as evidenced by the frequent earthquakes in this vicinity. Between Dec. 6, 1903, and May 3, 1904, the writer experienced eight distant shocks, four distinct ones occurring on April 27.

† "The presence of Ampullinopsis among the shells is indicative of this age."—Letter from Dr. Wm. H. Dall.

Of the just stated thickness at the outcrop was the "Big Tree" seam from which a sample lot of 10 tons gave highly satisfactory results when thoroughly tested on board the U. S. Army Transport "Wright" late in April, 1904. Compared with the "Kishima" coal from Japan, tried almost simultaneously under identical conditions, the Batan coal was found to contain 25 per cent more lump, to produce the same speed of 13.3 knots per ton per hour, to yield less dark smoke, and to leave no clinkers instead of many, and only 9.8 per cent of dry refuse instead of 19 per cent. There was also less work involved in firing with the Batan fuel, owing to its superior cleanliness, low ash content, and little waste.

Determinations made by me on a number of samples taken within 50 feet of the outcrop of this particular bed showed an average specific gravity of

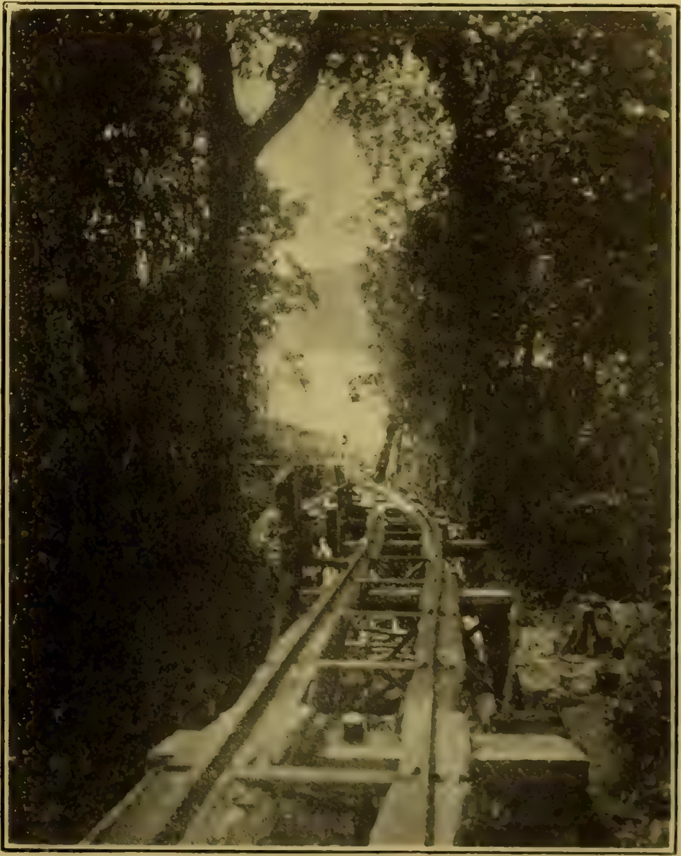

Photo by Deberri.

THE COMPLETED RAILWAY, LOOKING DOWN A HEAVY GRADE TO THE COAL HARBOR.

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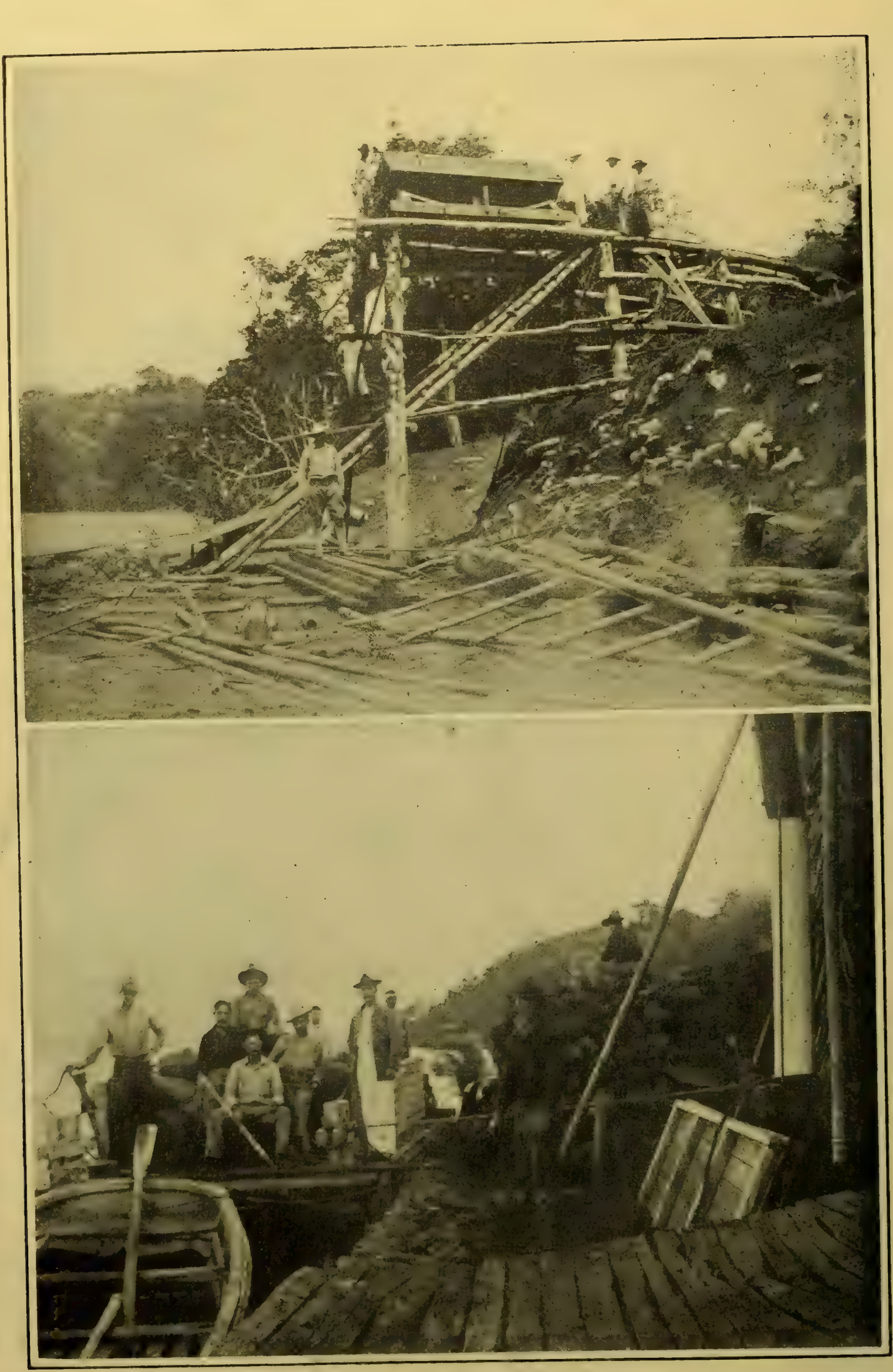
* One of the private claims within the reservation, tunnelled into a short distance many years ago.



BRINGING THE COAL TO TIDE-WATER.

The upper view shows a provisional tipple at the dock; the lower, a corner of the stone dock itself, with a coal-laden lighter.

1.35 in the natural state. The hardness and the crushing strength of the Batan coal was sufficient for it to be practically unaffected by more or less rough usage incidental to its being twice dumped down long slides in the course of transportation. A limited number of experiments demonstrated that the coal possessed coking qualities.

BIG TREE SEAM ON THE SAN FRANCISCO PERTINENCIA.

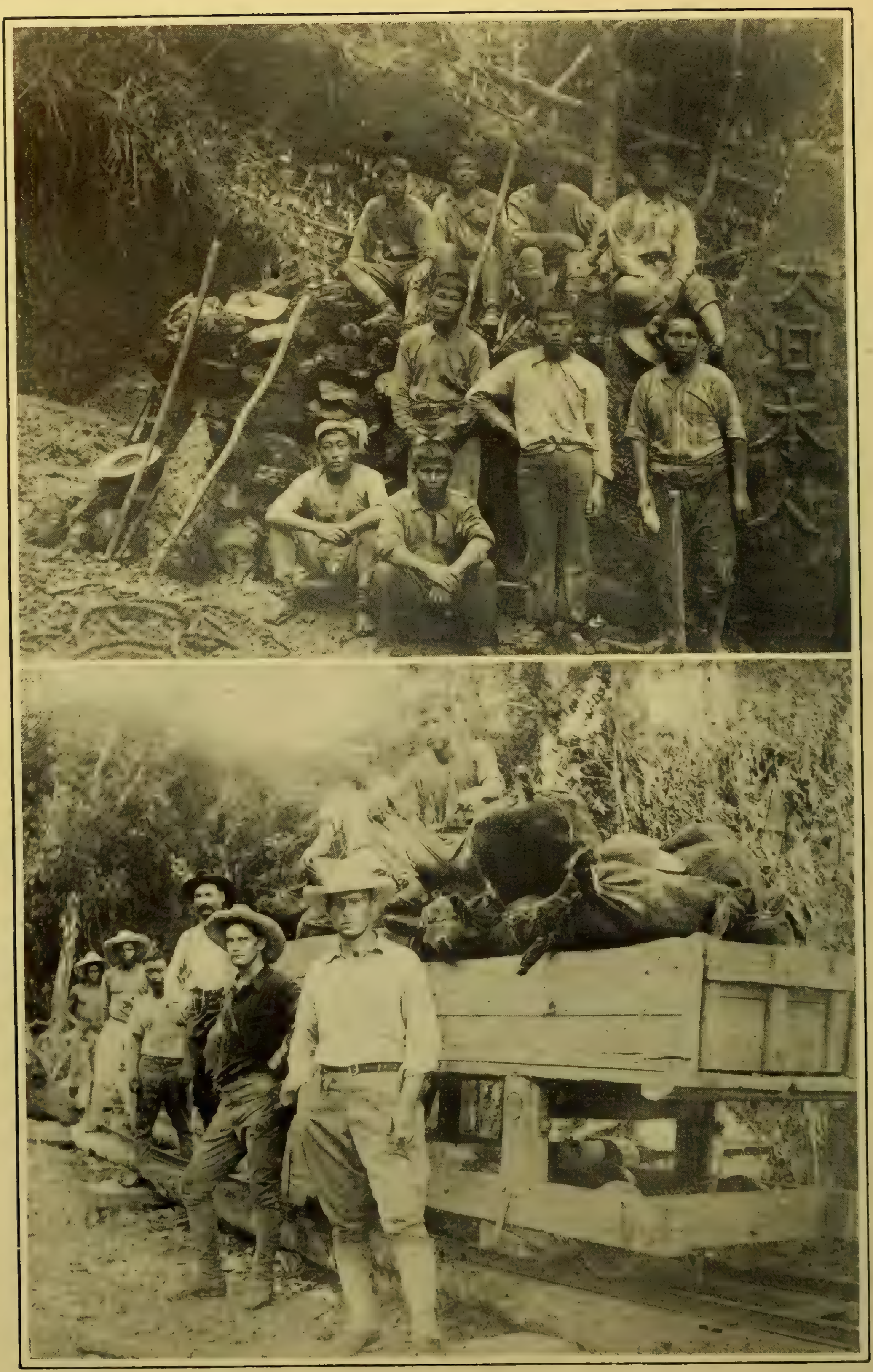
A bed of 7.7 ft. of excellent lignito-bituminous coal, with a northerly dip of 11 degrees. Both floor and roof are shales.

Chemical analyses would indicate that the fuel is a low-grade bituminous or lignito-bituminous coal, like the best soft coal of the Yampa field in Colorado, rather than a mere lignite. The volatile combustibles approached 40 per cent, while the fixed carbon in several cases exceeded 50 per cent. The ash content varied from 4 to 7 per cent, and the moisture a little higher, but generally less than 10 per cent. There was present, mainly in the form of marcasite, less than 1 per cent of sulphur, or not enough of this undesirable element to prevent the fuel being used even for smelting purposes if it were otherwise suitable.

JAPANESE OFFICIALS AND EMPLOYEES, BILBAO MINE.

The Japanese mining engineer, Mr. Gato, is leaning on his cane above the tunnel. Below are coolies, in characteristic poses, carrying out coal in baskets. Tram cars were introduced later.

On the whole, the results achieved in exploring the Batan coal field were not at all disappointing, though probable difficulties for future mining were revealed. The quality of the fuel proved satisfactory, and likewise the quantity underlying the area examined with



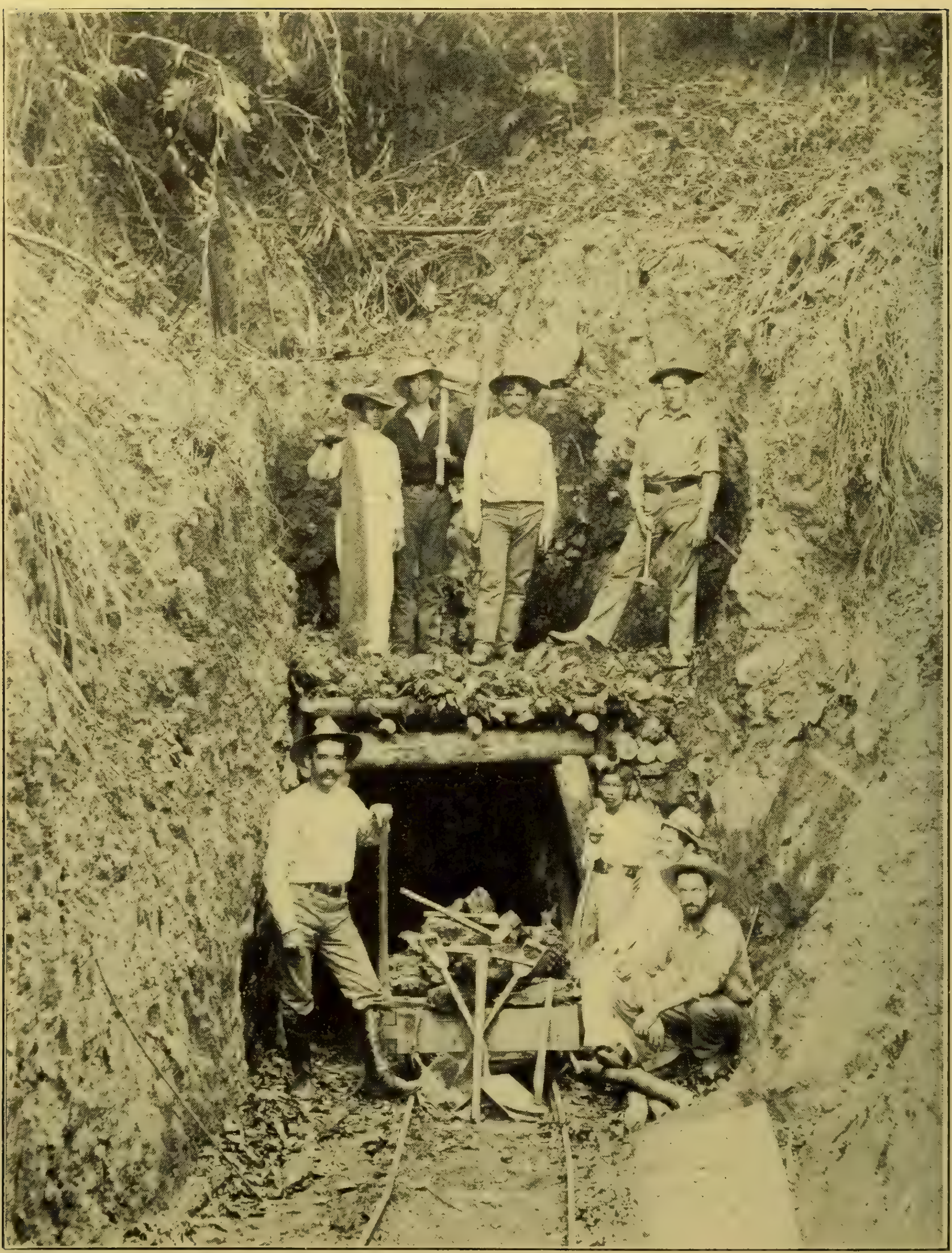
THE FIRST CAR OF COAL LOWERED TO THE RAILWAY TERMINAL, AND THE MINERS. Lieutenant Wigmore is in the foreground of the lower picture. The Japanese miners are shown grouped above. Just before the picture was taken, March, 1904, they had heard of a victory won by their countrymen 2,000 miles away, and had commemorated the occasion by decorating the large piece of coal on the right with the clay letters *Dai Niphon*—"Great Japan."

COAL FROM THE BIG TREE SEAM ON THE DOCK, WAITING TRANSFER TO THE BRIGANTINE LYING IN THE HARBOR.

The large masses, intact after rough handling in transit from the mine a mile away, prove the fine physical quality of the coal.

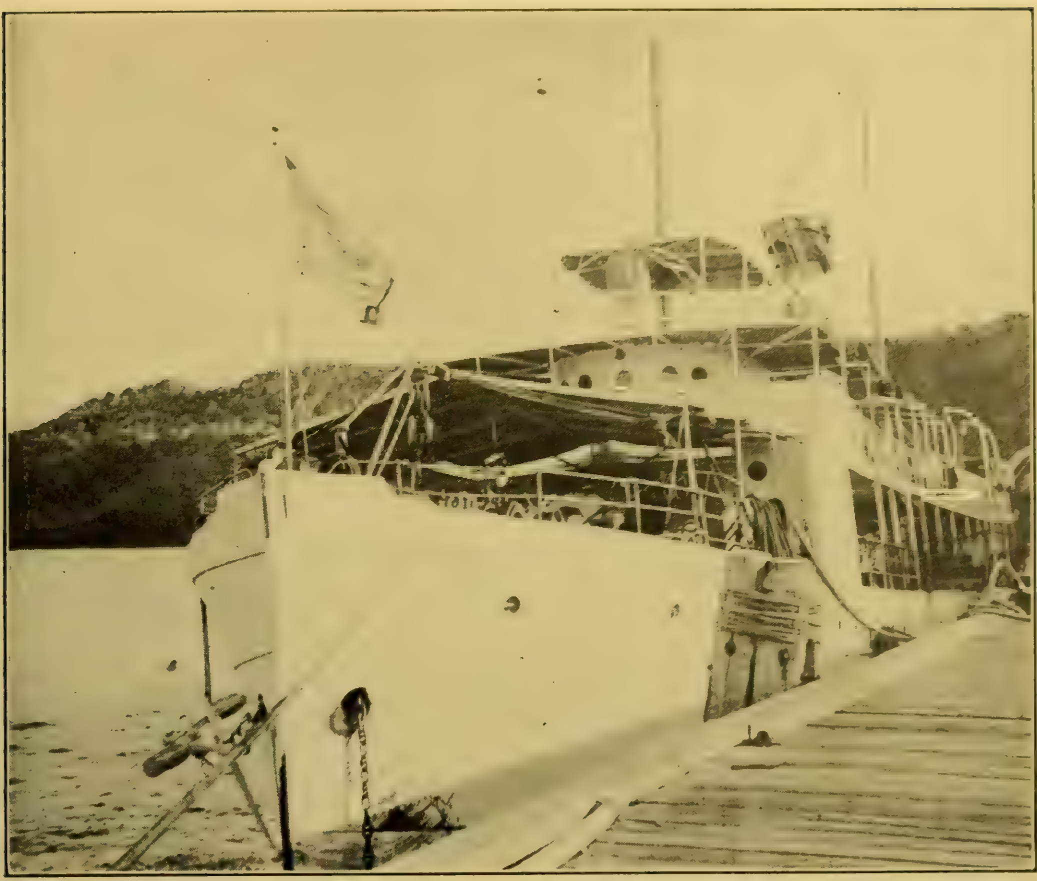
drills. Meanwhile, until the authorities act upon Lieutenant Wigmore's recommendation to work these deposits on Batan island, other promising fields in the Philippines will be given attention under the auspices of the Manila Mining Bureau, of which Mr. Hiram D. McCaskey is the chief.

The Government is justly encouraged in believing that an abundant supply of really serviceable steaming coal exists in these islands. It has direct access to the latest facts concerning the Philippine coal measures, not yet made available to the public, and has gained already much experience of a practical nature essential in developing these deposits. It has at its disposal wider opportunities and greater power and perseverance than can be looked for among any individuals or groups of individuals who might become interested in exploiting this most valuable mineral asset of the archipelago. As already pointed out, the Government, be it the military or the civil division of the same, need not become alarmed at the possibility of injuring private interests, for there are none of these established in coal-mining in the islands on anything like a productive basis.



ADIT TO ONE OF THE COAL BEDS LOCATED BY DRILLING.

Should the Government then, if it wishes to mine coal in the Philippines, hesitate to help itself and by its example help others? Hardly so, I think, in these days of national operation of coal mines abroad and of public clamoring for Government ownership of various monopolies in the United States. It will be noted that this is a contention for the creation of a Government industry, not for the



THE TRANSPORT "WRIGHT" AT QUARANTINE DOCK, MARIVALES, MANILA BAY.
Comparative tests of Japanese and Batan coal were made on this vessel in April, 1904.

purpose of filling private wants, but for the partial supplying of a single need of the Federal Government by drawing upon one of the latent resources of a distant possession.

The Government has authority to reserve unlimited areas of unoccupied lands for purposes of coal-mining on its own account, something which it has once availed itself of as recorded in the past pages. There is a limit, however, on the amount of coal land which private persons may acquire. The following is abstracted from the new Coal Land Law enacted April 28, 1904, but based upon the earlier one of July 1, 1902:

A properly qualified individual, such as a citizen of the United States, may purchase 64 hectares (158 acres), and an association of such persons, 128 hectares (316 acres), but no more, of "unappropriated public land which is chiefly valuable for coal." If no adverse claim be made during the required nine consecutive weeks' publication of the notice of application "the applicant is entitled to a patent upon payment * * * * * of 50 pesos ($25 U. S. currency) per hectare ($10.12 per acre) where the land shall be situated more than fifteen miles from any completed railroad, available harbor, or navigable stream, and 100 pesos ($50 U. S. currency) per hectare ($20.23 per acre) for such lands as shall be within fifteen miles of such road, harbor, or stream."

A REVIEW OF CONDITIONS IN THE AMERICAN IRON INDUSTRY.

By Edwin C. Eckel.

Mr. Eckel's review brings out with admirable clearness the most interesting features of one of the most interesting years in the history of the American steel industry. Not the least significant of the points he makes is that concerning the comparative ore reserves of the Lake Superior district and of the Southern States. It is possible that the facts of this matter, which have not heretofore appeared in print, have been rather overlooked by the Northern iron and steel magnates in their consolidation plans and arrangements.—THE EDITORS.

IN the course of a recent article* dealing with the various mineral products of the United States, the iron ores and iron industry were described, of necessity very briefly, attention being called merely to their great industrial importance and to their relative rank as compared with the precious metals. The present article contains a somewhat more detailed discussion of the American iron industry, including under that head both the raw materials and the finished products of iron manufacture. The subject can be most naturally handled by describing first the iron ores of the United States, then the production of iron and steel, and finally the position held by the country, as compared with other nations, in the iron industry as a whole.

It is proper to state here that the data on pig-iron and steel production used in this article are those collected by the American Iron and Steel Association; and that the results for 1905 are presented by the writer through the courtesy of Mr. J. M. Swank, Secretary of that organization.

I. The Iron Ores of the United States.—The commanding position which the United States has attained in the iron industry has been largely due, of course, to its supplies of raw materials and to the enormous demand caused by the development of the country, and directed exclusively to home producers by the operation of the protective tariff; for other countries have been able to secure cheaper labor and equally extensive markets. The transportation systems, too, have aided greatly in the development of the American iron industry, making it possible for Pennsylvania and New York furnaces to draw their ore supplies from Minnesota, and still make iron at a profit.

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* "The Mineral Industries of the United States," THE ENGINEERING MAGAZINE, November, 1905.

The distribution of developed iron ores throughout the country is well shown in the following table, in which the production of the various States for 1903 and 1904 is given separately. It will be seen that Minnesota is by far the most important producer, turning out annually over 40 per cent of the total. Michigan follows, producing about one-fourth of the whole output, and Alabama is third with about one-eighth. The other States are of much less importance.

	1903.	1904.
Minnesota	15.371,396	12,728,835
Michigan	10,600,330	7,089,887
Alabama	3,684,960	3,669,881
New York....	540,460	842,303
Va. and W.-Va.	801,161	550,253
Tennessee	852,704	500,982
New Jersey....	484,796	499,949
Wisconsin	675,053	483.475
Pennsylvania .	644.599	397,107
Georgia	443,452	293,802
Mont., Nev., N. M., Tex., Utah, Wyo..	426,292	210,945
Colorado	252,909	150,972
North Carolina	75,252	64,347
Missouri	63,380	49.285
Kentucky	32,227	35.000
Conn. & Mass.	30,729	21,990
Ohio	29,688	15.672
Maryland	9,920	9.645
Total U. S..	35,019,308	27,644,330

The statistics of production given above for the separate States are rendered much more intelligible and useful when the States are combined in their natural commercial groups, as has been done in the table following:

	Tons.	Per cent.	Tons.	Per cent.
	1903.		1904.	
Lake Superior District...........	26,646,779	76.1	20,302,197	73.4
Southern United States...........	5,997,106	17.1	5,223,195	18.9
Central and Eastern United States.	1,730,272	4.9	1,777,021	6.4
Rocky Mountain States............	645,151	1.9	341,917	1.3
	35,019,308	100.0	27,644.330	100.0

During these years, therefore, the Lake Superior district furnished about three-fourths of the total supply of iron ores. Detailed figures for 1905 are, unfortunately, not yet available; but it seems probable that they will show not only a greatly increased tonnage over either 1903 or 1904, but a relative increase in the output of the Lake Superior district. During the shipping season of 1905, up to Nov. 3, the amount of ore shipped from Lake Superior ports was 29,730,615 tons, as compared with 17,657,159 tons shipped during the corresponding portion of 1903. This would indicate a total production in the Lake Superior district of over 33,000,000 tons. The southern mines did not expand their output, in response to the increased demand for ore, as rapidly as did the Lake mines, and I think it safe to say that during 1905 the Lake district probably produced almost 80 per cent of the total iron-ore output. Allowing, as above noted, 33,000,000 tons

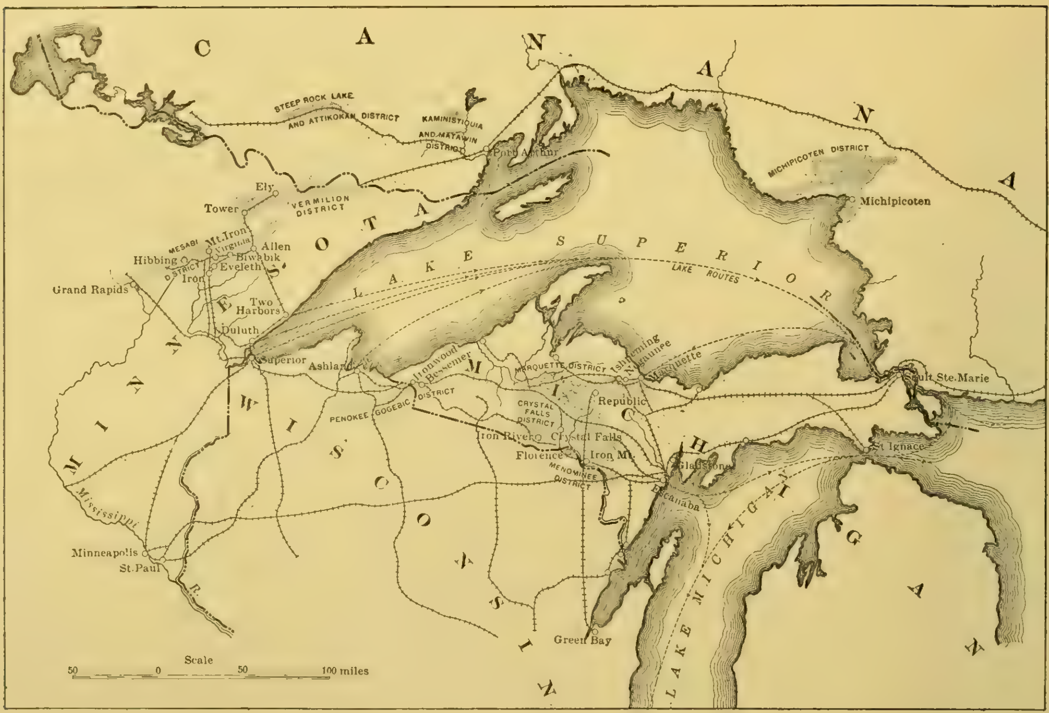

FIG. I. SKETCH MAP OF LAKE SUPERIOR IRON REGION, SHOWING ORE DEPOSITS, SHIPPING PORTS, AND TRANSPORTATION LINES.

as the probable total of Lake ore mined during 1905, the total for the entire United States can hardly fall below 45,000,000 tons.

The enormous iron-ore deposits which are included in the Lake Superior district occur, as shown in Figure 1, in the States of Minnesota, Michigan and Wisconsin. Closely allied deposits occur across the border in Canada, but these need only be alluded to in the present connection.

The Lake Superior ores are mostly hematites, with much smaller proportions of magnetite. The Mesabi range, the most recently opened of the great ranges, produces a fine-grained ore which can be excavated readily by steam shovel. Objections by furnacemen to the use of this fine ore are gradually passing away, and the Mesabi is now the most important of the Lake ranges.

A few charcoal furnaces are running near these deposits, but by far the greater part of the Lake ore is shipped east to Chicago, Cleveland, Pittsburg, Buffalo, etc. Most of the ores are of bessemer grade, and carry in the neighborhood of 60 per cent of metallic iron. During the early part of 1905 Lake ores from the Mesabi range were delivered at Lake Erie ports for $3.50 per ton (bessemer) and $3.00 per ton (non-bessemer). No very accurate figures as to the amount of iron ore still remaining in the Lake district are available. A common estimate, however, is that this reserve amounts to 1,500,000,000 tons of ore carrying over 50 per cent metallic iron. The ore below that grade, of course, is still very abundant.

Next in importance to the Lake district is the Southeastern United States. Here, particularly in east Tennessee, north Alabama and northeast Georgia, oolitic red hematites or "fossil ores" are extensively mined. These ores range, below water level, from 33 to 40 per cent in metallic iron, but are too high in phosphorus to be of bessemer grade. They can be delivered at the furnaces at a cost of 80 cents to $1.10 per ton, a price far lower *per unit of iron,* than any of the Lake ores. The extent of these red-ore deposits has been much underestimated by those unfamiliar with the district. In the course of my recent work in Alabama I have made a crude preliminary estimate of the available ore reserve, and think it safe to say that in Alabama alone there are still almost 1,000,000,000 tons of red ore above the thousand-foot level. The total red-ore reserves of Alabama, Georgia, and Tennessee are without doubt far in excess of those of the Lake Superior district. Brown ores occur in the same area, which with careful washing may average 48 per cent metallic iron, and sell for $1.50 to $2.50 per ton. These brown ores are also silicious and non-bessemer, so that the Southern industry has been toward making foundry irons.

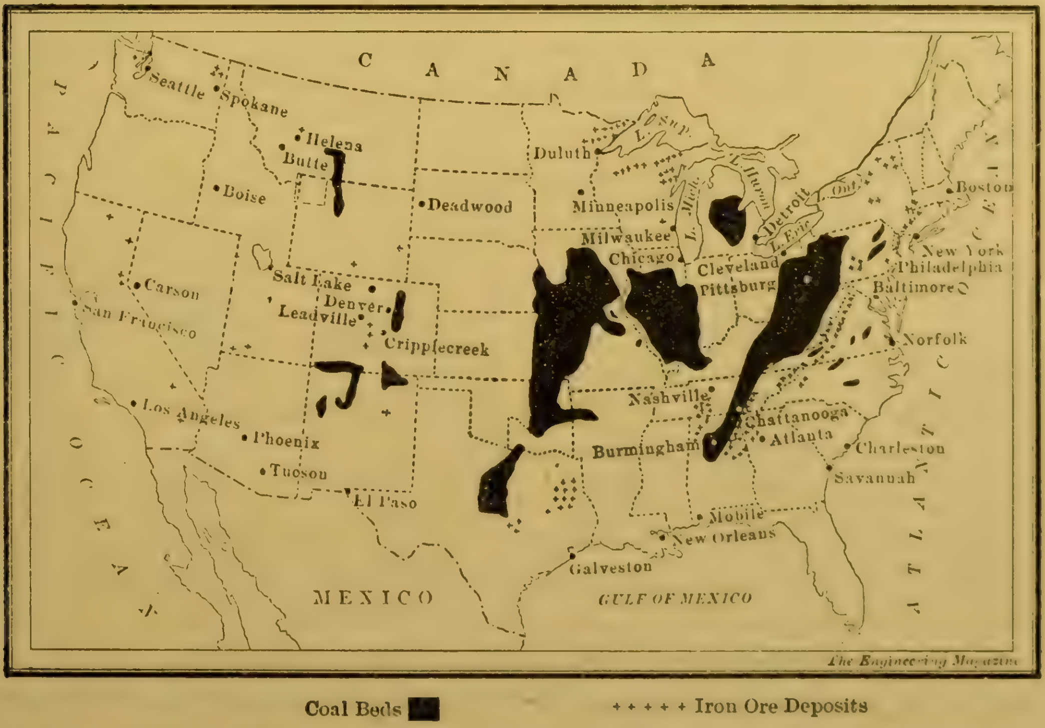

FIG. 2. MAP OF THE UNITED STATES, SHOWING THE PRINCIPAL COAL AND IRON DEPOSITS.

Open-hearth-steel plants are now, however, taking a fair share of the product, and in consequence many furnaces in the Southern United States now run on basic iron exclusively.

II. The Iron Industry of the United States.—It has been pointed out elsewhere that the location of the iron and steel industries is determined by the fuel supplies. In other words, under ordinary trade conditions, the iron ore will be hauled to the coal fields, rather than the opposite. This condition may be expected to prevail so long as fuel is used directly in the furnace. If the time ever comes when electric smelting is successful, we may expect to see iron and steel produced near the iron mines, where water power is usually plentiful.

At present, however, very different conditions prevail. Pennsylvania, for example, where only about half a million tons of iron ore are mined, makes eight million tons or more of pig iron. Ohio shows a similar disproportion between raw material and product; and Illinois, ranking third in its production of pig iron, does not mine a single ton of ore. The States of Minnesota, Michigan and Wisconsin, on the other hand, which furnish over three-fourths of the American ore, produce a very small percentage of pig iron.

It may here be noted that a considerable tonnage of Cuban and Spanish ores reaches the United States every year, the bulk of this importation being used by the Maryland Steel Co.

A glance at statistics of the pig-iron production of the United States, arranged by States, will serve to show the distribution of the iron industry.

PRODUCTION OF PIG IRON IN 1903 AND 1904, BY STATES.

[Long tons.]

State.	1903.	1904.
Pennsylvania ..	8,211,500	7,644,321
Ohio	3,287,434	2,977,929
Illinois	1,692,375	1,655,991
Alabama	1,561,398	1,453,513
New York	552,917	605,709
Virginia	544,034	310,526
Tennessee	418,368	302,096
Maryland	324,570	293,441
Wisconsin ..... Minnesota	283,516	210,404
Missouri....... Colorado ...... Washington ...	270,289	151,776
Michigan	244,709	233,225
New Jersey ...	211,667	262,294
West Virginia..	199,013	270,945
Kentucky	102,441	37,106
North Carolina. Georgia	75,602	70,156
Connecticut ...	14,501	8,922
Texas	11,653	5,530
Massachusetts .	3,265	3,149
Total......	18,009,252	16,497,033

Complete detailed figures for 1905 are not available, but the production of pig iron for the first six months of 1905 is given in the table on the next page, comparison being made with the two halves of 1904.

	1904. 1st Half.	1904. 2d Half.	1905. 1st Half.
Massachusetts and Connecticut.....	5,567	6,504	7,636
New York	250,980	354,729	550,208
New Jersey	121,294	141,000	165,991
Pennsylvania	3,713,867	3,930,454	5,226,691
Maryland	135,416	158,025	156,334
Virginia	186,037	124,489	240,672
North Carolina, Georgia and Texas	44,342	31,344	25,752
Alabama	800,256	653,257	743,547
West Virginia	103,153	167,792	149,016
Kentucky	17,516	19,590	32,793
Tennessee	165,883	136,213	195,757
Ohio	1,540,743	1,437,186	2,181,058
Illinois	798,221	857,770	979,157
Michigan	138,744	94,481	147,953
Wisconsin and Minnesota.........	104,437	104,967	184,234
Mo., Colo., Oregon and Washington	46,982	104,794	176,376
Total..........................	8,173,438	8,323,595	11,163,175

The very marked increase in production, which began in March of 1905, is very noticeable in this comparative statement. Though detailed statistics for the entire year are not at hand, Mr. Swank informs me that the total production of pig iron for 1905 will probably be in the neighborhood of 23,000,000 tons, a figure far in excess of any previous year.*

The fact above noted, that iron furnaces are located in the coal fields, and not necessarily near the iron mines, is well brought out when the figures above given are grouped and compared with the production of iron ore. This has been done in the following little table:

	1903.		1904.		First half of 1905.
	Per cent. ore.	Per cent. pig iron.	Per cent. ore.	Per cent. pig iron.	Per cent. pig iron.
Lake Superior District..............	76.1	2.9	73.4	2.7	3.1
Southern United States..............	17.1	18.3	18.9	16.8	14.0
Central and Eastern United States...	4.9	77.6	6.4	79.7	81.4
Rocky Mountain States..............	1.9	1.2	1.3	0.8	1.4

The two districts which exercise most influence over the iron industry may be considered as centering respectively at Pittsburg and Birmingham. Conditions in the two areas are very different, in many respects. The Pittsburg district has cheap fuel of excellent quality; high-grade bessemer ores are shipped in quite cheaply from Lake Superior; and the States near the furnaces supply an active and enormous market for the finished product. The Birmingham district, on the other hand, has large deposits of low-grade, non-bessemer, but self-fluxing ores located within a few miles of the furnaces; cheap but not particularly good coals; and a very poor local market for finished products. Contrary to the general opinion, Alabama has little if any advantage over Pennsylvania in regard to labor. The negro is very inefficient, and the "poor white" is almost worthless; and though labor unions play little part in the Birmingham district, the pay of even common labor has increased 50 to 75 per cent in the past five years.

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* The conditions in iron production are at present so stable that this estimate, based on ten months' production, is subject to very little probability of error.

These conditions show on the cost sheet in very striking fashion. The fact that the Birmingham furnaces can secure all their raw materials—ore, coke and limestone—within a few miles of the plant makes possible much lower costs there than in Pittsburg. But these much lower costs do not necessarily mean a very much higher margin of profit. Until the bulk of Southern pig iron is used in Southern steel plants, and the steel sold to Southern manufacturers, most of the profits of Southern iron-making will go to the railroads.

The fact that costs are lower in Alabama than in Pennsylvania is well enough known, but the comparison of costs at a few selected furnaces in each State would hardly give results of value. Fortunately a broader basis for comparison is in existence.

The massive reports of the Twelfth Census (1900) contain a large amount of valuable and carefully concealed information on the cost of production of iron and steel. Careful examination shows that the data there given can be treated so as to give very exactly the cost per ton of the iron produced in the different States. This has been done for several important States, and the results are given below:

Cost of Production of Coke Iron, per Ton, 1900.

Alabama	$8.12
Tennessee	9.97
Illinois	10.12
Pennsylvania	11.23
Virginia	12.12

The items included in these costs are raw materials (ores, fuels, flux), wages, salaries, and repairs. This comparison of the costs in various States shows strikingly the strong position of the Birmingham district as compared, for example, with Pittsburg. The drawback to Alabama, of course, is that its local market is not extensive enough, so that much of its product must be shipped north and west in competition with the Pennsylvania and Ohio irons.

At present Pittsburg and Birmingham—using these localities as typical of their districts—are the controlling factors in the American iron industry. The part to be played by the West is still doubtful. Large deposits of high-grade ore are known to occur in the Rocky

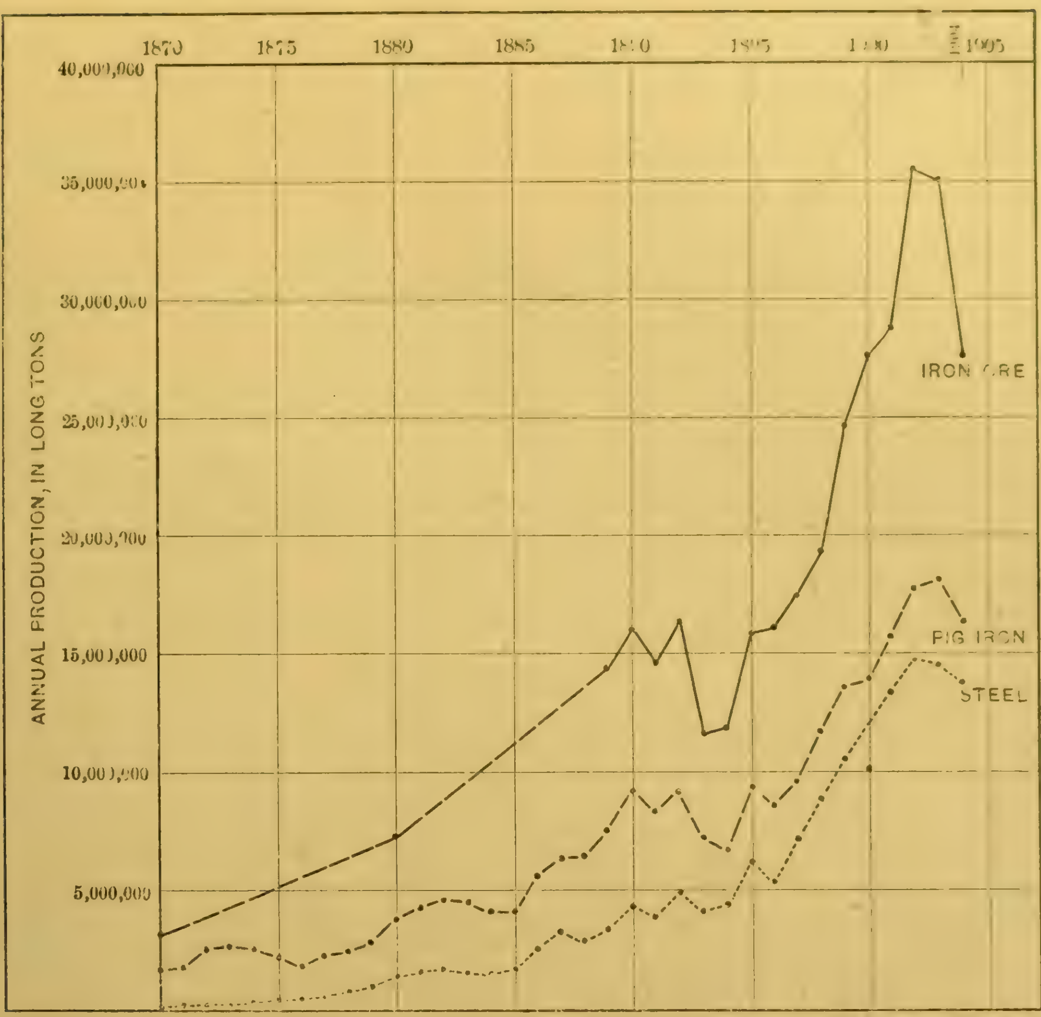

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FIG. 3. AMERICAN PRODUCTION OF IRON ORES, PIG IRON, AND STEEL, 1870-1904.

Mountain and Pacific States, but fuel supplies are by no means so satisfactory, and as yet the local markets are undeveloped. The furnaces and steel plant of the Colorado Fuel and Iron Co., at Pueblo, Colorado, mark the first serious attempt to create a western iron center. An interesting feature of the 1905 situation was the purchase of 100,000 tons of Lake Superior ore by the Colorado Company. The great demand for iron and steel had over-run the immediate supplies from their own western mines, and necessitated the bold experiment of buying ore in Minnesota. The ore was sold on a basis of $2.15 per ton at the mine, and was carried 1,273 miles over four railroad systems for $4.50 per ton, thus costing $6.65 per ton at the Pueblo furnaces. In other words, each ton of pig iron made from this ore would cost about $11.00 for ore alone.

III. America's Rank as an Iron and Steel Producer.—The United States has for some time past led in the production of iron ores, of

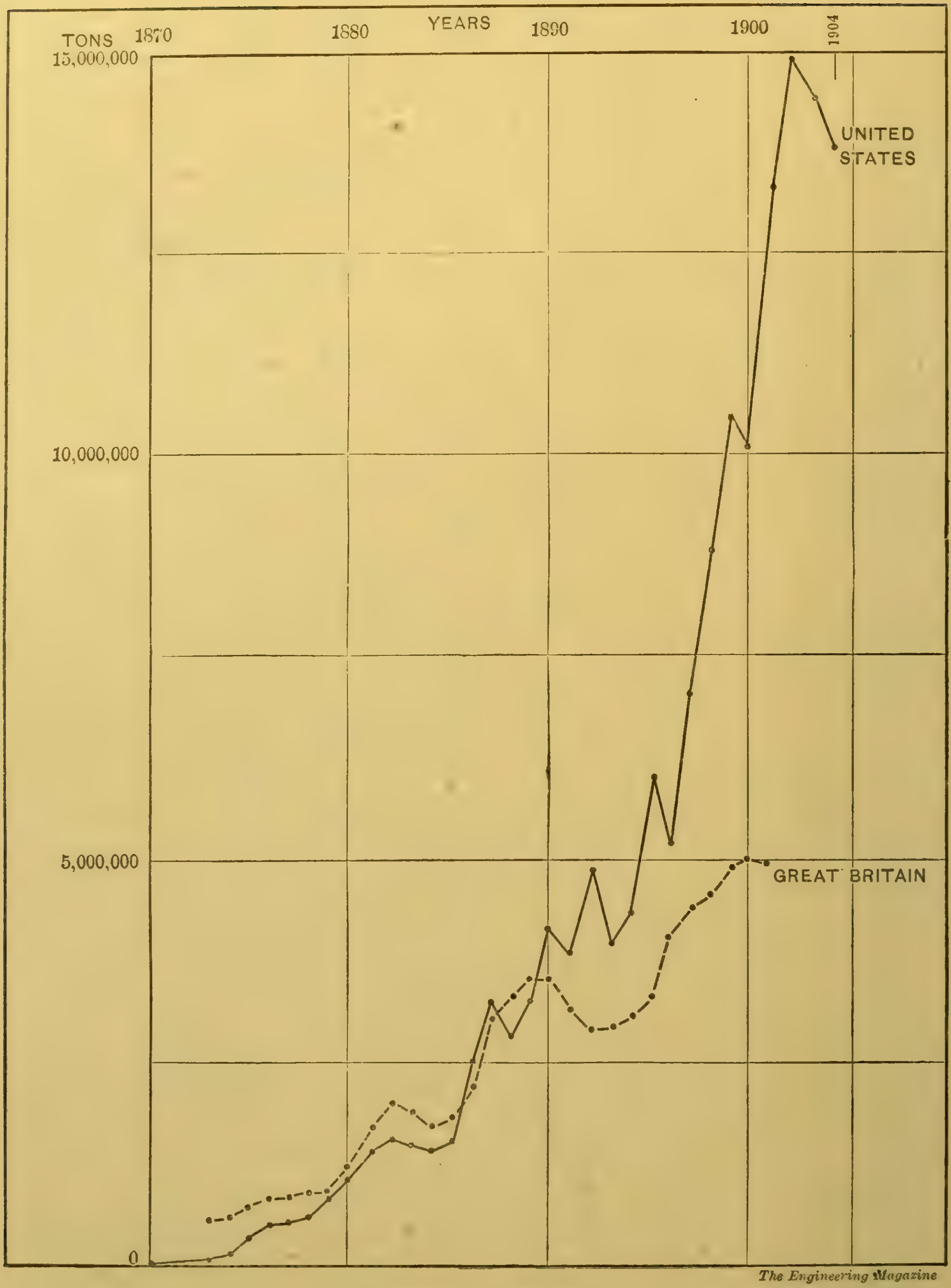


FIG. 4. AMERICAN AND ENGLISH PRODUCTION OF STEEL, 1870-1904.

pig iron, and of steel; and for the past few years has produced rather more than a third of the world's output of each of these materials. In all three Germany is a fairly close second, producing usually from 20 to 25 per cent of the world's total; while Great Britain is third with 15 to 20 per cent. The three leading nations are, however, less equally matched than this summary might seem to show, at least so far as the probabilities of the future are concerned. The United States and Germany have shown fairly steady annual increases, not only in absolute tonnage but in percentage of the world's output; while Britain has practically remained stationary for a decade or more. The three nations above mentioned produce together three-fourths or more of all the iron and steel. The remainder of the output is divided among many countries, France, Russia, Austria and Belgium being the more prominent of these minor producers. Canada, despite a heavy bounty granted by the Dominion Government, is still of little importance in the iron industry. Her iron ores are of excellent quality, but the best deposits are located far from the Canadian coal mines.

In the following table the world's production of iron ore, pig iron, and steel is given in some detail for the year 1903, the last for which complete statistics are available. The production of the leading nations for 1904 is, however, on record; and these have been added.

	1903.			1904.		
	Iron ore.	Pig iron.	Steel.	Iron ore.	Pig iron.	Steel.
U. S.	35,019,308	18,009,252	14,534,978	27,644,330	16,497,033	13,859,887
Gt. Britain	13,715,645	8,935,063	5,134,101	13,774,282	8,562,658	5,026,879
Germany .	21,230,650	10,085,634	8,801,515	22,047,297	10,103,941	8,930,291
France ..	6,219,541	2,840,517	1,885,000	....	2,999,787	2,080,554
Belgium .	184,400	1,216,500	969,230	....	1,307,399	1,083,000
Austria ..	3,269,175	1,428,158	*1,193,000	....	....	....
Russia ...	4,218,600	2,486,610	2,410,938	5,272,300	2,978,325	2,811,948
Sweden .	3,677,841	506,825	318,897	4,084,647	528,525	332,571
Spain ...	8,304,153	302,657	199,642	....	....	....
Italy	374,790	75,279	187,642	....	....	....
Canada...	235,977	265,418	181,514	312,286	270,942	148,784
Cuba.....	624,858	....	....	....	....	....
Other countries	3,780,435	248,744	66,112	....	....	....
Total..	100,255,373	46,400,657	35,882,288		....	....

* 1902.

Of the two years whose statistics are given in the above table, 1903 was prosperous rather above the average, while 1904 was a year of low prices and extreme depression in the American iron and steel industries. The year just past, however, showed a very active market and it seems probable that the present prosperity will last well into 1906. High prices for part of 1906, at least, are assured, for many large purchasers of ore and pig iron, for delivery in the spring, have already been made at prices highly remunerative to the miner and furnaceman.

So far as can be learned, other countries have not shared equally with the United States in the remarkable advance which took place in 1905; and whenever comparative statistics for that year are available, it will probably be found that America produced 40 per cent or more of the world's output of iron ore, pig iron, and steel.

THE UTILISATION OF LOW-GRADE FUELS FOR STEAM GENERATION.

By W. Francis Goodrich.

In a preceding paper, published in this Magazine last month, Mr. Goodrich took up in detail the results secured in the practical use of various small and low-grade fuels under working conditions in the power plant. In the concluding section, now presented, he deals more particularly with the adaptations of the boiler furnace and other appliances to the burning of low-grade combustibles, though in developing the subject he exhibits the results secured with some fuel materials of considerable local importance and recently the subject of much interested inquiry.—The Editors.

WHENEVER a fair evaporative efficiency is required from a boiler to be fired with a fuel containing over 30 per cent of incombustible, it may be submitted that the external firebrick cell is the best method of effecting proper combustion. With the average boiler of either the Lancashire or water-tube type the grate area is not sufficient, and with boilers of both types the close proximity of cooling surface in the form of plates and tubes respectively adds materially to the difficulty presented in burning such fuels. With a water-tube boiler having an extra large grate and a modified setting, the conditions are certainly more favourable; but the ideal conditions are presented in the external firebrick cell.

Under such conditions it is possible to provide a grate area which is otherwise impracticable. Taking for example a Lancashire boiler 30 feet by 8 feet which with internal furnaces would have a grate area of 38 square feet—that is, grates 6 feet in length by 3 feet 2 inches wide. In order to fire this boiler with the gases from a very low-grade pit-bank refuse, an external firebrick cell having either 50 or 75 square feet of grate area might be provided. With this large grate area and artificial draught it is possible to burn a very considerable quantity of inferior fuel, obtaining an evaporative efficiency from the boiler which could not possibly be secured under any other conditions.

With ordinary internal furnaces in a large Lancashire boiler, it requires a good natural draught and an unusual activity upon the part of the fireman to burn 10 hundredweights of Welsh steam coal per hour. With an external cell having 50 square feet of grate, placed in front of a similar boiler, it is an easy matter to burn 30 hundredweights of pit-bank waste per hour; the latter fuel may only have an evaporative value of 4 pounds of water per pound of fuel, but burned at a greatly increased rate of combustion on an increased grate area it becomes a simple matter to evaporate more than 10,000 pounds of water per hour with one Lancashire boiler 30 feet by 8 feet.

For the past three years a very poor colliery shale has been thus disposed of at some two or three Yorkshire collieries, and unpromising as this fuel would appear to be from the appended figures it has nevertheless proved to be quite suitable for obtaining the maximum evaporative efficiency from the boiler.

Shale—Glass Houghton & Castleford Colliery Co.

(A)	Shale—size, 3-inch squares.	
	Calorific value	1,933 B. T. U. per pound.
	Volatile matter	16.60 per cent.
	Ash	11.6 per cent.
(B)	Shale—size, 6-inch squares.	
	Calorific value	2,416 B. T. U. per pound.
	Volatile matter	20.16 per cent.
	Ash	63.80 per cent.
(C)	Shale—size, 3-inch squares.	
	Calorific value	6,573 B. T. U. per pound.
	Volatile matter	25.73 per cent.
	Ash	19.43 per cent.

With the external firebrick cell the use of forced draught is essential; up to the present, indeed, it has been clearly demonstrated even with internal furnaces that for burning the lowest grades of fuel forced draught is far more suitable than induced draught. The poorer the quality of the fuel the more clearly has it been shown that forced draught, provided either by means of a centrifugal fan or steam-jet blowers, is far better adapted for the efficient combustion than is induced draught. If for purposes of argument we select what is perhaps the very lowest grade of fuel used in any considerable quantity, that is, towns' refuse—we are bound to admit that while forced draught has amply fulfilled all requirements under a great variety of conditions, induced draught wherever tried has failed to satisfy.

In connection with a large and recently erected destructor installation in India, forced draught has been provided in addition to induced draught, and this in spite of the fact that most elaborate arrangements are made for the preliminary drying of the refuse. This course was doubtless dictated as the result of experiments in a London works, where it was found that induced draught alone was not suitable for the efficient cremation of sorted towns' refuse.

The smoke-abatement experiments with native fuels recently conducted on behalf of the Indian Government in Calcutta by Mr. Frederick Grover conclusively proved the value of the Dutch oven, or semi-external furnace, in connection with water-tube boilers. Low-grade slack fuels with a high percentage of volatile matter were burned without smoke under such conditions, whereas it was shown that the same fuels could not be consumed smokelessly with such mechanical stokers as have been adopted in Calcutta. Here we have demonstrated the necessity for and the value of what my good friend Mr. W. H. Booth would term "common-sense environment." As I have stated many times, I am in cordial agreement with Mr. Booth; it is impossible to burn very low-grade fuels containing a high percentage of volatile matter to the very best advantage, and with a complete immunity from smoke troubles, unless they are burned in an incandescent firebrick cell.

It has been urged by some that the number of heat units absorbed by the large area of brickwork is excessive, and that this represents a serious loss in actual heat transmitted through heating surfaces; but there is really little in this contention. The actual heat value absorbed in the brickwork is recouped again and again by the rapid ignition of the gases and the intense and well sustained temperature of the gases passing to the boiler.

Objection has been made to the external firebrick furnace, because it is feared that it would be costly in maintenance and upkeep. While it is true that such a furnace may prove very costly if badly designed and constructed, or if very poor material is used in construction, it is equally true that if the best workmanship and materials are employed such a furnace will cost no more for maintenance than many steam users cheerfully pay for firebars alone.

External furnaces cannot be recommended under all conditions and for every class of fuel; but it is beyond all question that in this type of furnace is presented the very best method of burning, for steam generation, such fuels as wood, peat, tan, coal with a heavy percentage of volatile matter, pit-bank and colliery waste, and all coal of a highly refractory nature and containing more than 35 per cent of incombustible. It is idle to argue that small coal, containing upwards of 35 per cent of incombustible or partaking of a shaly nature, can be burned in any internal boiler furnace, either machine or hand-fired, while enabling the boiler to be worked well beyond its rated capacity. The conditions are all against such a result being obtained, and although it may be glibly promised it cannot be done excepting on a short test with an expert fireman.

If the steam user is content to work his boiler up to one half (or even less) of its rated capacity, then it is possible, with suitable furnaces, to burn a very poor fuel—always providing that the fireman can be persuaded to do his part. Owing to the limited grate area, however, and the necessity for frequent cleaning of the fires, due to the presence of a high percentage of clinker, the work is very heavy.

So far as Great Britain is concerned, much yet remains to be done in the satisfactory burning of wood as a fuel. In the wood-working industry comparatively little has been done in this direction so far, and average British practice when compared with that in Finland, for instance, approaches the ludicrous. We have often been reminded that next to coal, wood is the staple fuel; and when its calorific value is borne in mind, it is indeed remarkable that so little has been accomplished in the burning of wood and wood-waste, under such conditions as ensure the maximum fuel value being obtained.

In a great number of works in Great Britain, wood is being wastefully burned in ordinary furnaces designed for good coal. In some cases wood alone is burned, in other cases it is mixed with coal, either large or small; indeed, it may be fairly observed that in many works good coal is being burned to consume the wood—a practice not at all uncommon, and entirely due to the ignorance of the British steam user, who too often is quite satisfied if he can generate such steam as he requires under any circumstances.

In many saw mills, etc., sufficient wood waste is available to provide the whole of the steam power required if such fuel is burned under the best conditions, and in this industry needless to add it would be very beneficial if coal accounts could be entirely closed. Such a desideratum, however, will be reached only by burning wood waste under those scientific conditions which will ensure the maximum value being secured, and fully utilised. The nature of the material is such that it can be best burned outside of the boiler in an external cell or furnace. The large grate area, the facilities for introducing heavy charges of such fuel with the minimum of effort, the trapping of the fine dust in a chamber outside of the boiler, together with the large area of incandescent firebrick lining—these present the really ideal conditions for burning wood or wood waste as a fuel. Under such conditions it is possible to burn a large quantity with the minimum of labor cost. Flue cleaning—a constant source of trouble when wood is burned in internal furnaces—is practically done away with; the smoke trouble does not arise; the incandescent firebrick walls ensure rapid ignition of the gases, and with satisfactory working, clear flame only comes into contact with the heating surface of the boiler.

Although comparatively little has been accomplished in this direction so far, enough has been done to show clearly that when sufficient wood or wood waste is available the use of coal can be entirely dispensed with.

Peat is a fuel which has been but little used for steam generation, largely because where such fuel is found in abundance, generally speaking, little if any outlet exists for its utilisation. It is nevertheless a very useful fuel, as will be evident by referring to the appended figures of a test carried out at the Sutton Electric Traction Station, County Dublin. It is but fair to add that in this instance the furnaces were not designed for dealing with such a fuel, being of the ordinary natural-draught type, the grate area corresponding to that which would be employed for a fuel of much higher calorific value. The tabular statement of the test appears on the opposite page.

The peat was absolutely pure, being macerated and dried by a patent process and costing at the factory six to seven shillings per ton. It will be clear upon referring to item number 36 in the table that had an economiser been installed, the evaporative efficiency of the fuel would have been at least 15 per cent higher.

Peat may be classed among those fuels which can be most efficiently employed for steam generation by being burned in an external firebrick cell, and under such conditions no difficulty would be experienced in obtaining a boiler efficiency equivalent to the best modern practice with expensive steam coal.

Unfortunately, peat (like Irish anthracite coal) is used to only a comparatively small extent in that country. Where these fuels are available in enormous quantities at a very low cost there are but few works requiring fuel, and while many works may be found within a reasonable radius, no facilities exist for cheap transportation of the fuel. Some years since, when visiting the Irish anthracite collieries, I found that coal for steam generation was actually being conveyed twenty miles by road.

During the past few years, mechanical stokers have been extensively adopted, and while they have by no means reached that perfect stage so persistently claimed for them by their makers, much excellent work has been done. Those who have closely followed steam generation in Great Britain during the past few years, will have observed that in the large cities and towns the smoke nuisance has been appreciably lessened, and this notwithstanding the ever increasing use of small bituminous fuels, and the fact that a far higher boiler efficiency is now demanded than was the case a few years since.

Evaporative Tests on Peat Fuel in Lancashire Boiler at Sutton Electric Tramway Power House, Co. Dublin.

1.	Date of Test	Nov. 1st, 1904.
2.	Between the hours of	10.30 P. M. and 12.30 A. M.
3.	Duration of Test	2 hours.
4.	Mean absolute Boiler Pressure	176 lb.
5.	Corresponding temperature	371° F.
6.	Mean Temperature of Feed Tank	52.2° F.
7.	Mean Temperature of air in open	51° F.
8.	Mean Temperature of air in Stokehold	56° F.
9.	Mean Temperature of Feed Water Heater Outlet	115.6° F.
10.	Increase of temperature due to Feed Water Heater	65.4° F.
11.	Factor of evaporation (basis 4-9)	1.1513.
12.	Total heat in 1 lb. of steam at 4 from 32° F.	1,195.14 B. T. U.
13.	" " " " " " water " 6 " 32° F.	18.3 B. T. U.
14.	" " " " " " " " 9 " 32° F.	83.53 B. T. U.
15.	B. T. U. added by heater per lb. 14-13	65.23 B. T. U.
16.	B. T. U. added by boiler per lb. 12-14	1,111.61 B. T. U.
17.	Grate area in square feet	35.
18.	Heating surface in square feet	902.
19.	Ratio of grate to boiler heating surface.	1 to 25.7.
20.	Total peat used during test	3,444 lb.
21.	Peat used per hour	1,722 lb.
22.	Peat used per sq. ft. of grate per hour	49 lb.
23.	Coal used per sq. ft. of Lancashire practice	18 to 21 lb.
24.	Peat used per hour per sq. ft. of boiler heating surface	1.9 lb.
25.	Total water used	11,910 lb.
26.	" " " per hour	5,955 lb.
27.	Water per sq. ft. of grate per hour	170 lb.
28.	Water per sq. ft. of grate usual Lancashire practice	160 lb.
29.	Water per sq. ft. of boiler heating surface per hour	6.6 lb.
30.	Water per sq. ft. of boiler heating surface usual Lancashire practice	3 to 6 lb.
31.	Water evaporated per lb. of peat	3.45 lb.
32.	Equivalent from and at 212° F.	3.97 lb.
33.	Ashes formed	67 lb.
34.	Percentage of ash to combustible	1.9 per cent.
35.	Average draught in chimney	.53 inches.
36.	Average temperature chimney base	565° F.
37.	Average temperature above boiler damper	Not ascertained.
38.	Cost of peat per ton	Assumed @ 12 shillings 6 pence delivered.
39.	Cost of evaporation 1,000 gallons	Say 15 shillings 6 pence.

Perhaps the most important improvement in connection with machine-fired furnaces during the past few years has been the combination of artificial draught. This combination has been valuable: (1) in bringing within the range of the mechanical stokers many small and inferior fuels, the use of which was previously restricted to hand-fired furnaces; (2) in enabling a far greater evaporative efficiency to be obtained from boilers; and (3) in assuring a greater certainty in the prevention of smoke, due to the efficiency of the air supply.

Ten years since, in order to work a coking stoker smokelessly, it was imperative to reduce the output of the boiler down to one-half of its rated capacity, and it was a common experience to find a Lancashire boiler 30 feet by 8 feet giving an evaporation of from 3,000 to 4,000 pounds per hour; now, a boiler of the same size fitted with coking stokers and forced draught and burning a similar fuel will evaporate from 12,000 to 14,000 pounds per hour, while keeping a clean chimney.

With sprinkling stokers, and artificial draught, a still heavier evaporative efficiency may be obtained from a boiler of similar size, but not with an entire freedom from smoke; and wherever the chimney draught is sharp, with stokers of this type, fine dust and grit is deposited in the flues and discharged from the chimney.

Experience has clearly shown that for smokeless working together with heavy boiler duty and a good fuel efficiency, the mechanical stoker working with natural or chimney draught alone cannot compete with the modern combined stoker and artificial draught.

For smokeless working the coking system is absolutely essential. For forty years past this type of stoker has been pre-eminent in this respect, and it will continue to hold its own. With water-tube boilers, the chain-grate stoker with modern improvements has a very satisfactory record, but unlike other modern coking stokers a small fuel of good quality, clean and practically free from dust, is demanded.

As at present arranged, the chain-grate stoker must be used either with natural draught, or induced draught; there are difficulties in the adaptation of forced draught, and so far as I am aware, this combination remains yet to be tried.

While for many years past slack coal has been burned with mechanical stokers, it is only within recent years that any machine-fired apparatus has been so designed that fine slacks with a good proportion of dust can be successfully burned. I am well aware that for a quarter of a century past it has been claimed for the mechanical stoker that it would satisfactorily deal with small fuels which could not be burned with any other form of furnace. In so far as many small and low grade fuels are concerned this was a mere claim and nothing more. It is only within the past few years that the mechanical stoker has been able to compete seriously with hand firing with many small fuels, and such a change has only been effected by the addition or combination of artificial draught with machine firing.

There are a wide range of fuels which demand a certain manipulation and treatment together with a definite intensity of draught, for their successful use, and it is obvious that the required manipulation may be given more satisfactorily by manual labor in hand firing than is possible with any machine-fired apparatus.

When everything possible has been said in favor of machine firing, we are still brought face to face with the fact that the mechanical stoker is limited in its range of usefulness. There are many fuels which cannot be successfully dealt with by any machine-fired furnace yet devised; I may mention just a few such fuels—towns' refuse, peat, wood, pan breeze, coke breeze, colliery waste, and the lowest grades of coal.

One is constantly asked whether towns' refuse cannot be mechanically fed; but up to the present there is no reason to suppose that such material will ever be machine fired. Machine firing is essentially suitable for an homogeneous material only, and there would appear to be but little prospect of any appliance being devised which will feed ashes, straw, mattresses, paper, and the hundred and one articles which go to make up average towns' refuse. But even assuming that suitable apparatus may be devised, it must not be forgotten that the mechanical process must inevitably cease with the feeding, because experience has clearly demonstrated that when such material is once on the grate it must be left alone until it is removed in the form of clinker. Firebars with a reciprocating motion cannot be used; any attempt to move such material renders active combustion impossible; if the mass is moved the fire is extinguished.

In this article I have endeavoured to show that many very low-grade and cheap fuels are not only well worth burning for steam generation, but also how such fuels may best be dealt with to ensure the realisation of their maximum calorific value.

A really first-class fireman, not a mere thrower-in of fuel, is a valuable servant; some of these men can with the shovel show results which cannot be improved upon by any machine-fired apparatus yet devised. Such firemen are, however, rare; the average fireman makes no secret of the fact that he prefers the very best fuel, and if it is to be obtained he will have it. Economic steam generation possesses no attraction for him; he prefers an expensive fuel because it requires the minimum of exertion on his part.

These are points which the steam user has often failed to grasp, and he would do well to bear in mind when he is disposed to reduce his fuel cost to the minimum, that the fireman is the very last individual who should be consulted thereon.

THE SQUARE DEAL IN WORKS MANAGEMENT.

By O. M. Becker.

I. THE COMMON-SENSE OF THE MANAGEMENT OF MEN.

It is regretfully admitted by many managers that while machinery has been brought to a high degree of perfection, *men* are almost as hard to manage as ever. Yet there are shops where labor troubles are scarcely known. What are the methods or what is the policy securing such happy results?

This is the question which Mr. Becker proposes to answer in the series of articles of which this is the first. His method will be chiefly that of evidence—by bringing forward actual examples of successful works and factories all over the country, and showing just what they do and *just how it pays.*

He has been intimately associated with one of the best manufacturing plants in the United States, and he writes as a practical man, for practical men. The present paper is chiefly introductory. The succeeding ones will take up: "What Can Be Done with the Plant"; "What Can Be Done with the Workmen"; and "The Auxiliary Methods of Successful Labor Employers."—THE EDITORS.

IN recent years there has been a growing tendency in the business and industrial world to recognize an ethical and social relation between employer and employed, and to acknowledge a moral test which the employer is bound to apply to that relation in the conduct of his business. Previous to the introduction of hand- and foot-power machinery, about a century and a half ago, practically all production was manual; and where the relation of employer and employed existed at all, it was of a close and personal nature. During the period following the advent of machinery—the period of the home factory—the owner of the machine was still in close personal relationship with those assisting him in his manufacturing enterprise, because the workers were chiefly members of his own family. The application of steam power to the driving of machinery, however, quickly brought about a remarkable change. The steam engine made possible the factory, with its concentration of power and the accompanying aggregation of operatives. Manifestly, the creation of a large class of wage earners (which naturally was contemporaneous with the development of the factory system) tended to minimize the possible points of contact between the workingman and the man for whom he worked. It remained for the modern factory system and corporate organization—based upon the production of everything upon the large scale and the minutest possible subdivision of labor—by the massing of great numbers of workers practically to close the door to any personal relation between the capitalist and the workingman.

"The operator might as well have his arm riveted to one of the machine's moving parts, so thoroughly is he become part of it."

Along with the passing of the small factory and the possibility of a personal contact of operator with operative, came also the practical displacement of the skilled mechanic by the piece worker—the machine tender who is skilled in doing but one infinitesimal part in the productive process. The development of machinery, undoubtedly one of the great blessings of mankind, has like other important advances in civilization left in its wake much that is evil. The machine tool as now designed tends to make of its tender merely a more or less mechanical attachment—a sort of additional lever or gear wheel endowed with a modicum of intelligence. Standing all day before his shrieking, chattering, nerve-racking machine, feeding into it for ten hours the little or big pieces as the case may be—one, two, five, ten, thirty thousand before the tension is relieved—the operator might just as well have his arm riveted to one of the machine's moving parts, so thoroughly is he identified with and become a part of

"The man comes to live a life itself so mechanical as to leave little inclination for the social and intellectual activities."

THE MAN PAST FORTY.

"The only thing for him is a gradual descent into other work requiring less expertness and less strenuousness, and consequently commanding less pay."

it. Under such conditions what could be more obvious than that the man tends to become lost in the machine, and ultimately comes to live a life itself so mechanical as to leave little inclination for social and intellectual activities?

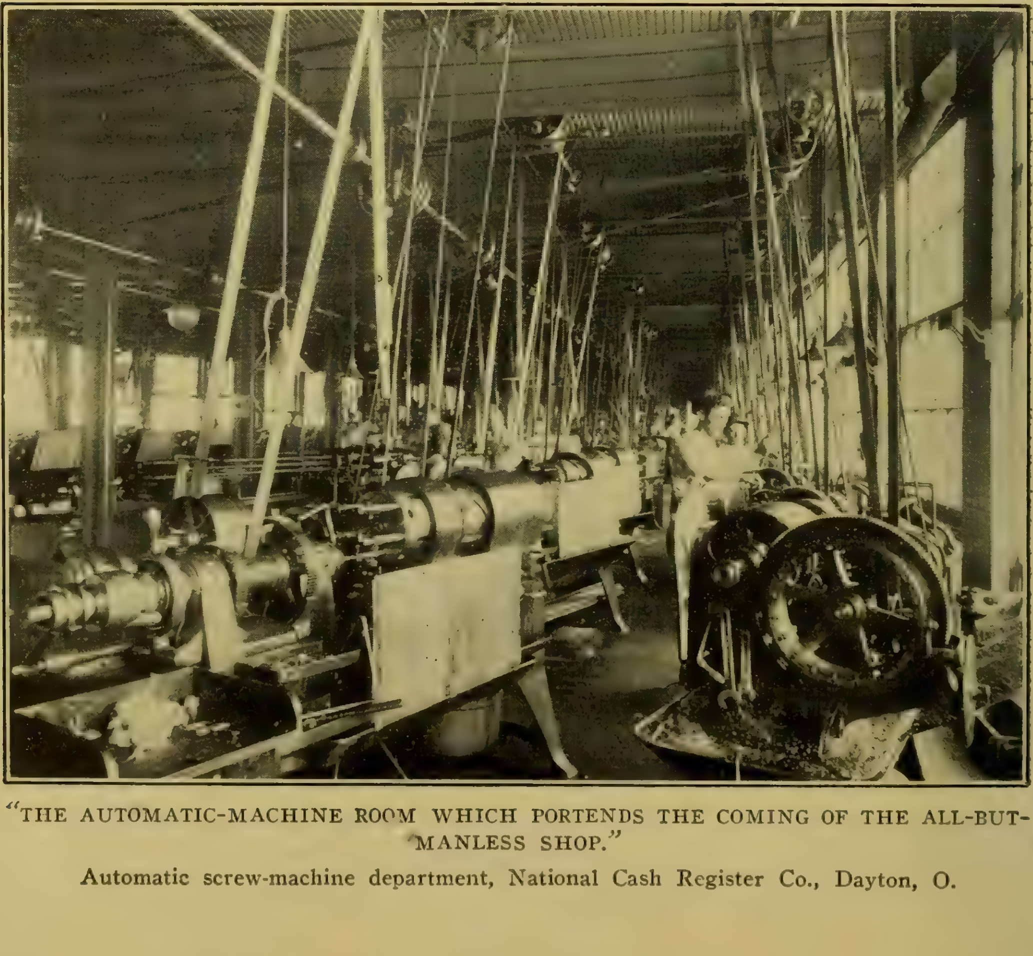
The tendency now is still further to speed up machinery; and it may therefore be expected, in spite of the belief of some that the limit of endurance has been reached in many cases, that the operative will gradually be worked up to a still higher speed and at a higher pressure than now. The disposition is more and more to replace machinery with other of later and more efficient design, so as to get the utmost possible in quantity and quality of product in the shortest practicable time. That is to say, as soon as it becomes apparent that a particular machine is no longer doing as efficient and therefore as economical work as another might, it is at once thrown into the scrap pile and the new one installed. As a part of the same policy—possibly a necessary part under present industrial conditions—there is a growing disposition to eliminate the old men among the operatives. For, inasmuch is the man is coming to be a part of the machine he tends, and like it is worked up to the highest limit of speed and endurance, he after a time shows signs of wear; he passes the critical period of efficiency and cannot longer maintain the tremendous rate at which he has been running. Under such circumstances he is no longer profitable to the capitalist and is therefore to be sent to the scrap pile along with his machine, and his place filled by a younger man. Startling evidence of such a disposition is found in the recent dismissal of many old employees by several of the great corporations. They had passed the "dead line." Younger men could be had cheaper, and with a little practice became more efficient. Similar evidence is to be seen at the employment office of practically every large business house. The man out of a job and on the shady side of forty stands little chance indeed of selection for any position, unless the supply of younger men similarly qualified (or even if not qualified, apparently promising) be considerably less than the demand. The only thing for him is a gradual descent into other work requiring less expertness and less strenuousness, and consequently commanding less pay.

Not only is the "dead line" an established fact in industry; but it is being drawn closer and tighter. A few years ago, forty-five was considered the limit of the average man's greatest productive efficiency. Forty, and even less, is now regarded as the critical point,

HOMES FOR OLD AND INCAPACITATED EMPLOYEES, BOURNEVILLE, ENGLAND.
Showing the provision made by Cadbury Bros. for taking care of wear and depreciation in the human machinery of their plant; the worn-out workman is honorably retired, not cast into the scrap pile with his machine.

doubtless with good reason. It is certain that as a machine is used the more strenuously, the more rapidly it wears out. The human machine, more delicately constructed than any product of human hands, is even more susceptible to wear; and if forty-five was ten years ago the critical point in the life of a producer, doubtless forty would at present closely represent the same productive capacity, because during the past ten years there has been a very marked speeding up all along the industrial line. Where the dead line will be drawn in another ten years remains to be seen. Let us hope that there will be a reaction favorable to the man with the experience. There are already intimations that such a reaction will come about—but whether through still further development of machinery, or through a more general recognition of the sacredness of human life and human mind, is not yet apparent; possibly through both agencies.

Now, whether it be of cold insensate metal or of human brawn throbbing with life, it is certainly good "business," when a machine has reached a point where it is no longer at its highest efficiency, to put it to less exacting service, or to retire it from service entirely. Carried out under conditions that take into account the ethics of the



"THE AUTOMATIC-MACHINE ROOM WHICH PORTENDS THE COMING OF THE ALL-BUT-MANLESS SHOP."

Automatic screw-machine department, National Cash Register Co., Dayton, O.

A DANCE EVENING FOR A GROUP OF CORE-MAKERS, McCORMICK WORKS OF THE INTERNATIONAL HARVESTER CO., CHICAGO.

It provides healthy social entertainment for the boys and girls, using a room ordinarily devoted to factory purposes. The clean conditions thus afforded replace and exclude the appeal which the highly-spiced attractions of the dance hall are otherwise too apt to make to young workers in the high-strung life of the shop.

case, there can be no valid objection to such a course applied to animate productive machinery. But the modern industrial system has as yet made no adequate provision for doing this. There are sporadic instances—a few in the United States, a few in England, and more in Germany and France. The situation in Germany probably comes closer to an equitable adjustment than elsewhere by reason of the compulsory and therefore universal system of pensions and disability payments by employers.* But in general little attention has been paid to this principle, a principle really fundamental to a safely conducted business, to wit: making provision for the depreciation of human machinery as well as for the other equipment of a plant. A business that cannot do this, or whose promoters will not do it, is safe neither for the investor nor the man employed in it.

The displacement of really skilled workmen by the almost automatic operations under the "piece-work" system; the dependence of the operative upon the machine; the segregation of workers in industrial centers; the constantly growing tendency to work machines and men at their topmost speed—all these things taken together have one inevitable result. The worker is drained of his vitality, and after a day's work not only has no energy left for living during the remainder of the twenty-four hours anything like the intellectual and social life that should be possible to him, but after a few years becomes a worn-out relic of this modern industrial system, a burden to society and to himself. There is here a tremendous problem, the satisfactory solution of which is important not only to the worker, but to the captain of industry as well; for however much machinery may be made to displace human strength and skill, there still remains the necessity of intelligent operation and tending of that machinery; so that unless provision be made for the preservation and development of a class of intelligent operatives, the industrial system must inevitably fall of its own weight.

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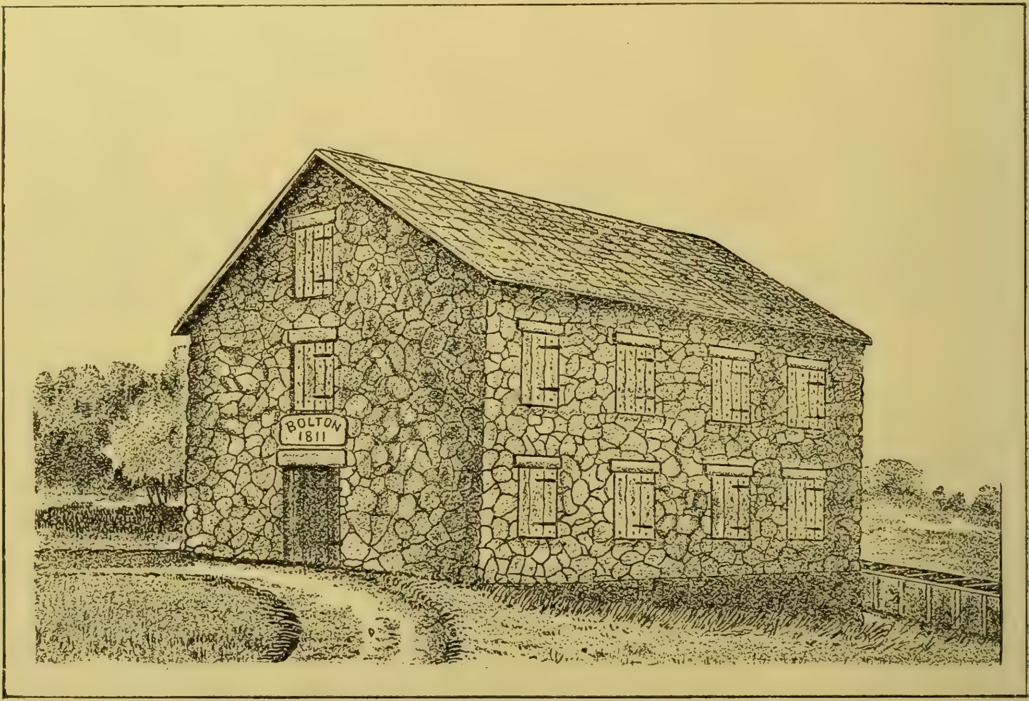
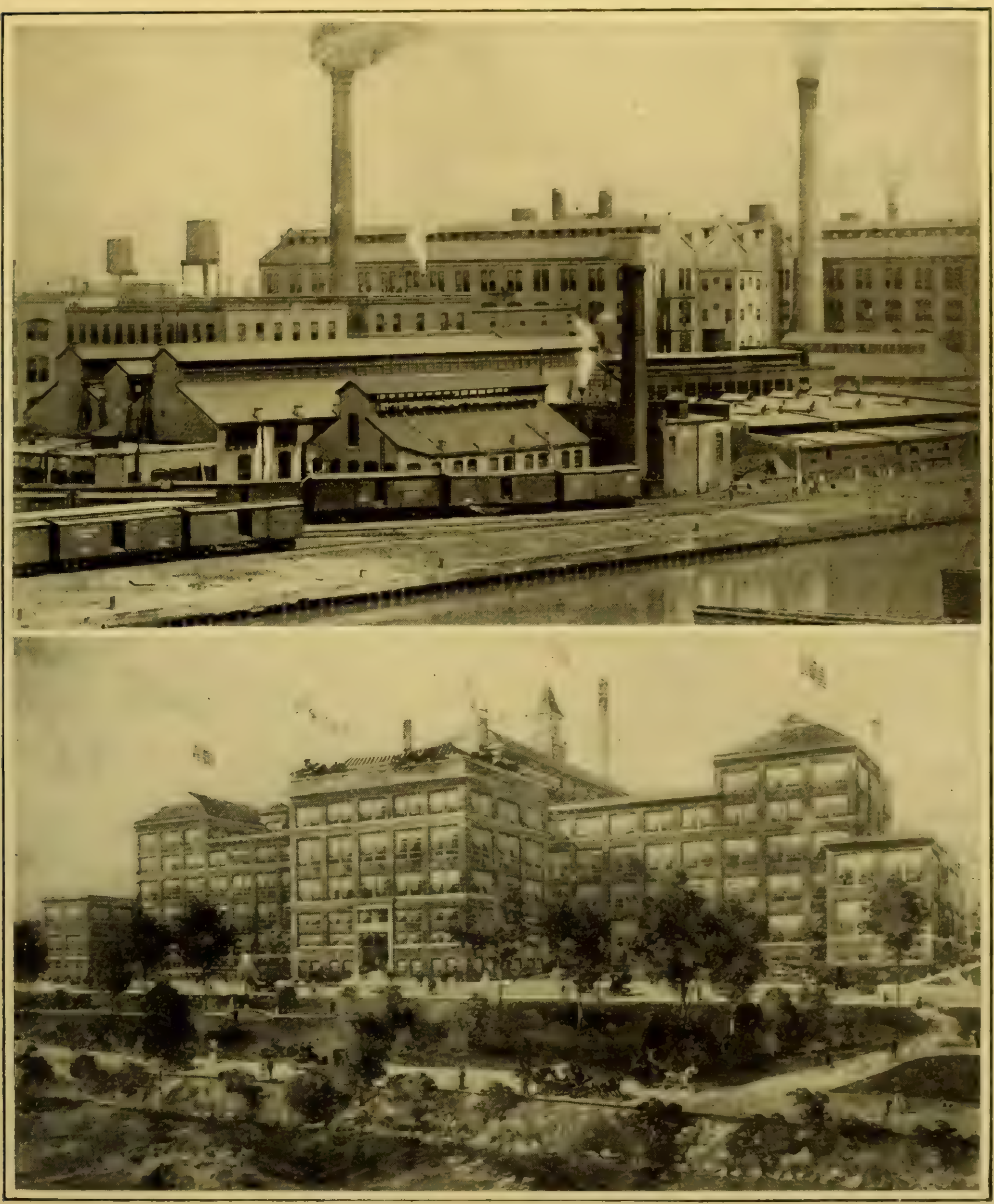
* This feature of the German industrial system, together with many other striking points in the modern economic policy of Germany, are more fully brought out in a keen analytical study of "The American and the German Peril," by Louis J. Magee, the first part of which appears elsewhere in this number of The Engineering Magazine.—The Editors.



A TYPE OF THE FACTORY OF A CENTURY AGO.
Bolton Mill, the first cotton mill in Georgia, built in 1811.

That there is such a problem, insistently demanding solution; that the human machinery is after all the most important part of a producing or trading plant; that there is possible an ideal relation between the man who works for wages and the man who pays the wages; that industry and trade are not on a safe basis unless there be made provision for both present and future welfare of the worker—all this



THE ADVANCED MODERN FACTORY, CONTRASTED WITH THE OLDER "ACCRETIONARY" TYPE OF CONSTRUCTION.

The buildings of the Natural Food Co., regarded by many as showing probably the most beautiful and thoroughly adapted example of factory architecture in the world, are illustrated in the lower view. They represent, perhaps, an ideal which comparatively few capitalists are inclined to approach. The upper picture exhibits the more usual present-day aggregation of buildings—ugly, crowded, and of varying degrees of adaptability to the purposes for which they are used.

has not yet dawned upon the world of business taken collectively. Nevertheless there have been men who saw clearly, almost from the time the factory system began to develop, the necessity for taking into account propositions so fundamental and so essential to industrial and commercial progress; and there is ample evidence that at the present time there is coming to be a lively interest and a desire for information among thoughtful employers as well as among students of social conditions. A sufficient number have taken hold of the problem and have worked it out far enough to show beyond cavil that "altruism"—a term which sifted down to its intended meaning, signifies only a just regard for others, and is practically equalled in homely phrase by "the square deal"—not only is a factor in business, but is an important factor, whether viewed with reference to self-interest or to sound ethics. Many others are looking askance, desiring to fulfil their obligations, but hesitating for fear of making mistakes; and still others hesitate to risk additional capital without the certainty of tangible return. On the whole, however, the situation is very encouraging.

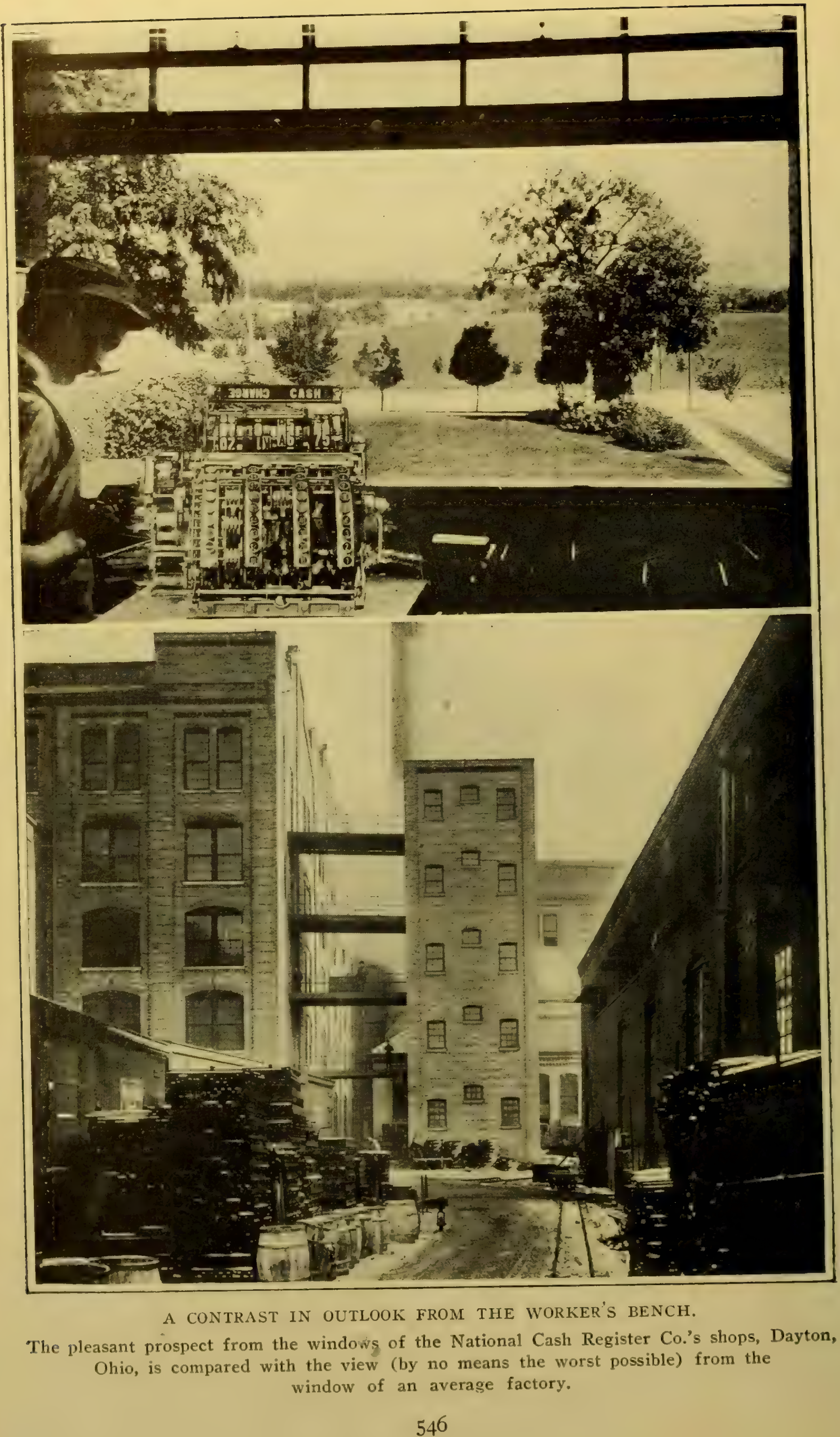
FACTORIES OF THE N. O. NELSON MANUFACTURING COMPANY, EDWARDSVILLE, ILL. Simplicity, order, architectural adaptation to purposes; ample room, with the vacant spaces plainly but neatly sodded and planted. A type well suited to suburban or country location.

The first to make a serious effort looking to the amelioration of the hard conditions under which factory operatives have worked was Robert Owen. First a cotton-mill superintendent and later an owner, Owen in the early years of the last century undertook to bring about a change in the social and moral conditions of his employees. However much modern factory and industrial conditions may be decried as lacking in human sympathy, in the first years of the factory period they were infinitely worse. At that time the oftentimes inhuman greed of the mill owners had not yet been restrained by effective factory legislation, and conditions were frequently so atrocious and revolting as to be scarcely believable.

In 1799, on coming into the management of the mills at New Lanark, Scotland, Owen set about working a regeneration in his community, not indeed without bitter opposition from the very people to be benefited. His first step was to provide for each workingmen and his family at least two rooms to live in. Large families had been accustomed to live in wretched hovels containing often not more than a single room, and the filth was utterly beyond description. The second step was to remove the filth that had accumulated in the streets and to encourage cleanliness and proper sanitation in the homes of the village. Under these vile conditions, as may well be imagined, intelligence and morality, were all but unknown. Shiftlessness, drunkenness, and poverty prevailed. Under the new *régime,* however, things shortly began to look a little different. Streets were no longer allowed to become obstructed by dung hills, drainage was provided, and the village began to take on a thrifty appearance.

THE MODEST HOME OF THE PROPRIETOR OF A LARGE MANUFACTURING PLANT.
Residence of Mr. N. O. Nelson, who lives among his employes in the industrial town he has built up outside but within easy reach of a large city, at Le Clair, Ill.

Schools were practically unknown in the community, so Owen built one and opened for the education of the children, the first infant school in Great Britain. A hospital for the sick and aged; a sort of club house for dancing, music and entertainments; a kitchen and eating house; facilities for washing and cleaning up after work; a library, and a lecture room—all these were provided for his employees, many of them the while cursing the new superintendent and threatening him



A CONTRAST IN OUTLOOK FROM THE WORKER'S BENCH.

The pleasant prospect from the windows of the National Cash Register Co.'s shops, Dayton, Ohio, is compared with the view (by no means the worst possible) from the window of an average factory.

with dire punishment for presuming to interfere with their established customs and personal freedom. At the same time stores were opened for the sale of everything needful in the village, all of superior quality and at reduced prices, with the result that the cheap retail shops whose chief business had been the sale of spirits were driven out. More important than all the other innovations, however, was the establishment in the New Lanark mills of what was practically a ten-hour work day with adequate wages—the first effort of the kind in the manufacturing industry. Of equal importance was the reform of child-labor conditions. Up to that time the children obliged to work in the mills had absolutely no protection against the brutality of the mill masters. Owen fixed the minimum age for employment in his mills at ten years—ridiculously low as we now look at it, but then a great step forward—and permitted those under twelve to work no more than six hours a day. Furthermore, certain educational qualifications were required of children precedent to employment in the mills, so that the schools were well patronized.

CANNOT THE MACHINE, CARRIED A STAGE FARTHER, REPLACE CHILD LABOR ENTIRELY?
In spite of its relatively low efficiency, child labor is used by many interests to as great an extent as the law allows. Its large supply and exceeding cheapness stand in the way of the fuller development of automatic machinery. Civilization pays the price in the resultant "debased coin" of physically and intellectually stunted and relatively incompetent industrial workers.

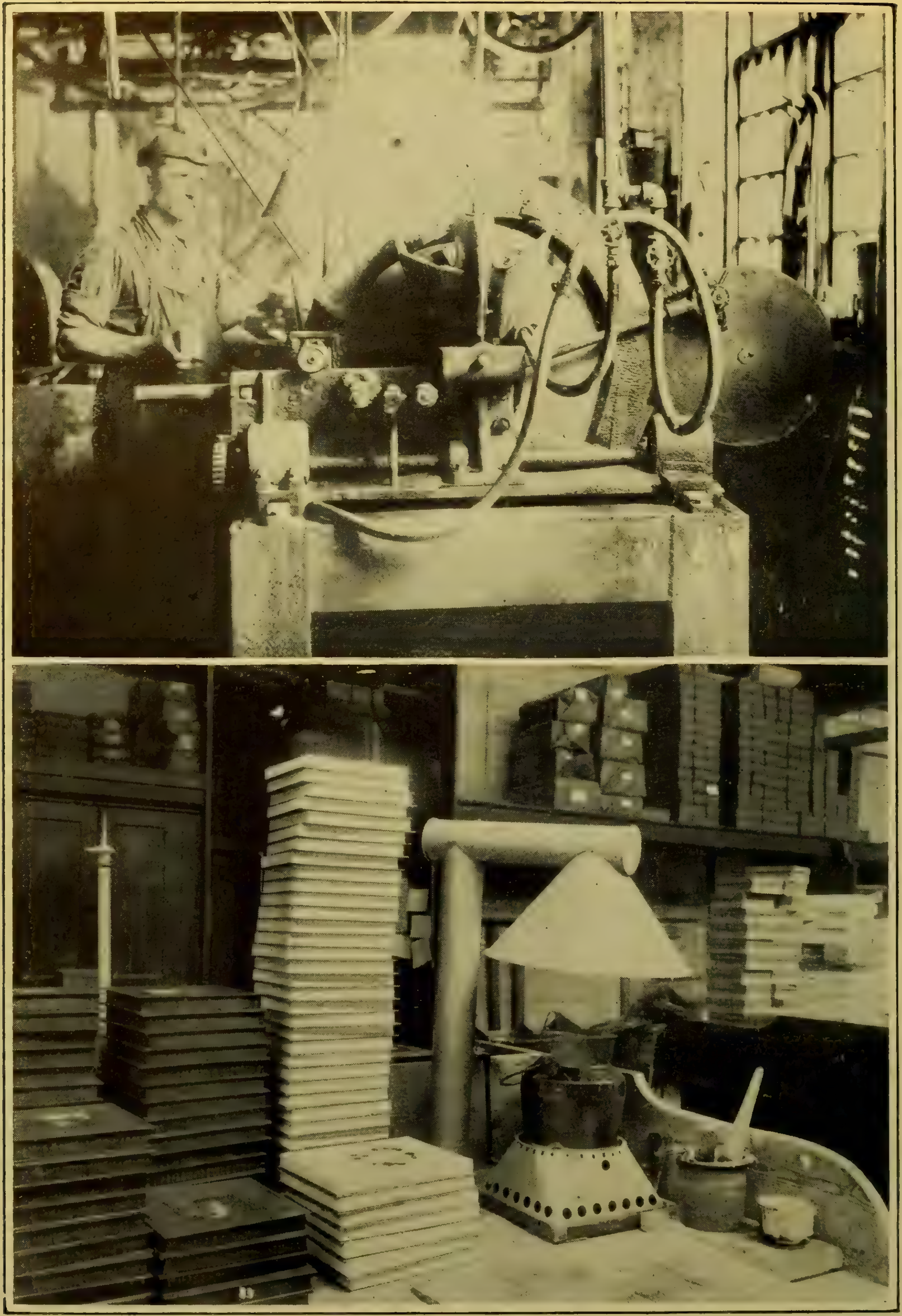
LIBRARY AND READING ROOM, FACTORY OF THE NATURAL FOOD CO., NIAGARA FALLS, N. Y.

In spite of difficulties and disagreements with more greedy and short-sighted partners, Owen's business conducted on such novel humanitarian lines succeeded amazingly and paid dividends much in excess of those previously realized; so that when he retired at the age of fifty-eight he was a very wealthy man.

The New Lanark experiment attracted a great deal of attention, as many as two-thousand visitors from all parts of the world having been to see this "model town," as it came to be known, in a single year. The example of this pioneer altruist was not, however, largely imitated; and it was only through the enactment of restraining laws from time to time in response to the demands of outraged public opinion that mill owners generally came to have any serious regard for the welfare of their operatives. The securing of such a code of factory laws was a slow and difficult process. The opposition of "vested interests," the influence of selfish operators, frequently the indifference of the operatives themselves, made it hard to secure any laws for the correction of even the most atrocious of the abuses that had sprung up. The employment of little children in the mills is a case in point. This particularly inhuman abuse finally reached a stage where public opinion intervened. Under the factory system the employees were always wretchedly poor and shiftless—almost necessarily so because of the conditions of wage and environment under which they worked. In consequence there were hordes of children that became charges upon the "rates" and were in the hands of the overseers of the poor. To reduce the public charges it became the custom to sell to mill owners for a period of years the services of these miserable little paupers. Often they were set at work long before they reached the age of ten, working, eating and sleeping in the same mill room. Some were found at work barely six years old and not tall enough to reach the working parts of the machines. They had been taught to get about on stilts. When tired, or sleepy, or weak, as was frequently the case because of the insufficient nourishment and the cruelly long hours—sometimes fifteen or sixteen a day—they were mercilessly flogged to their tasks. No wonder the child mortality was frightful. Even such revelations were alone insufficient to secure remedial legislation, and it required the active and unremitting efforts of men like Owen to induce Parliament to pass effective laws for the protection of operatives in the face of the opposition of the "vested interests."

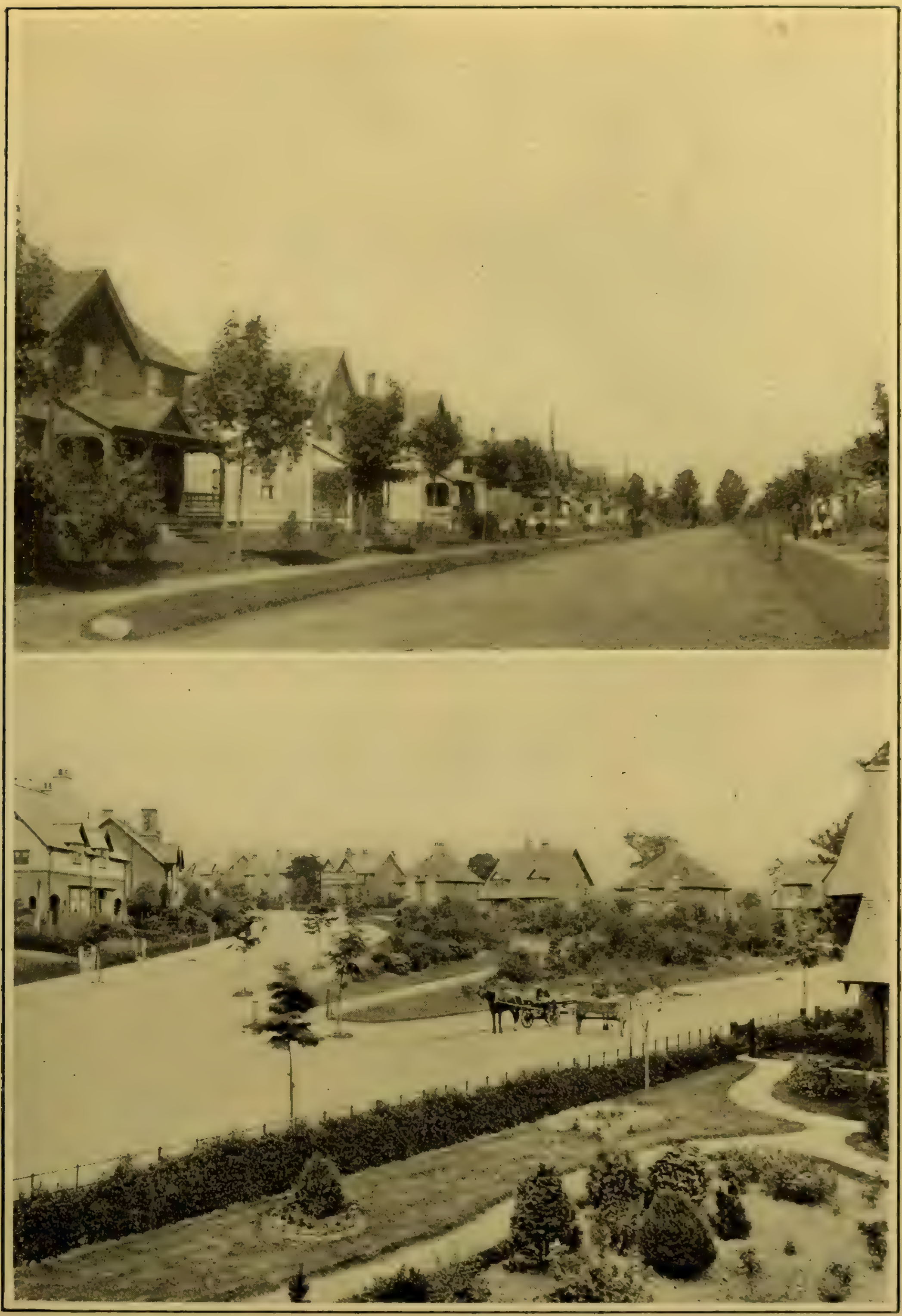
There were, of course, notable exceptions among employers; and the abuses described were undoubtedly extreme cases. But there is

TYPICAL AUDIENCE OF FACTORY PEOPLE, AUDITORIUM OF THE H. J. HEINZ CO., PITTSBURG, PA.



A CONTRAST OF CONDITIONS OBTAINABLE IN FACTORY OPERATIONS.

The upper view shows a disgraceful condition surrounding the wet grinding of small pieces, no effort being made to remove moisture and suspended particles of stone and steel, with which the air becomes filled. The lower picture illustrates a situation where almost equally offensive conditions might arise. The exhaust over the glue pot, and the cleanliness exacted in this paper-box shop, make the working environment hygienic as well as agreeable. This view is taken in the Cadbury Cocoa Works.



TWO EXAMPLES OF WHAT MAY BE DONE WITH EMPLOYEES' RESIDENCES.

Both illustrate the fruits of the policy of taking as much interest in the workpeople as in the machinery of the plant. The upper view is a street in Ludlow, Mass., showing the dwellings rented or sold to employees of the Ludlow Mfg. Associates. The lower scene is in Bourneville, England, where Messrs. Cadbury Bros. have partially solved the housing problem by taking the factory into the country, and leaving the worst features of city factory neighborhoods behind.

McCORMICK WORKS CLUB, INTERNATIONAL HARVESTER CO., CHICAGO.
Contains lunch room (convertible into an auditorium), baths, smoking and game rooms, lodge and society hall, and class rooms for evening classes.

nothing in the history of industry to indicate that, until recently, there has been any general disposition to recognize the moral obligation of employer to worker and to mitigate as far as possible the evils of the

AN OLD FACTORY OFFICE BUILDING CONVERTED INTO A SCHOOL FOR GIRLS.
Ludlow Manufacturing Associates, Ludlow, Mass. The building is the center of many of the social and educational interests of the female employees.

industrial system. That there is such a disposition at the present time is not open to doubt. The feeling is growing in the world of industry and trade that it is "good business" to treat the human part of the productive and distributive machinery humanely and even considerately; to provide employees with safe, decent, comfortable, and (so far as possible) agreeable surroundings, and with opportunities for recreation and intellectual development. How much the growing power of trades unionism and the unsettled condition of the labor market has to do with this feeling, and how much is due to an increasing sense of moral obligation, it is not to the present purpose to inquire. Apparently both are factors. The most important factor in the minds of many business men who are becoming interested in the subject is that it pays dividends. The thoughtful employer is finding that it is not merely philanthropy to do what he can to make his employees cheerful, happy and content; but that it is a paying investment, yielding tangible returns as well as intangible. One large manufacturer* has gone so far as to figure out in dollars and cents the gain resulting from certain improved conditions. Surely nothing could be more tangible than that. The same gentleman said recently, in summing up his experience: "One of the most profitable investments that can be made in a manufacturing plant is to give the largest possible advantages in the way of conveniences and sanitary arrangements. Every kind of legitimate comfort and convenience that may be provided for operatives is a source of profit to the employer, although apart from the moral obligation to care for the health and comfort of the employe." Another gentleman† doing a large business, who has within two or three years made a serious effort to get into close touch with his work people by giving them greatly improved conditions and surroundings, was asked the question, "Does it pay?" In reply he said, among other things: "Three years ago we had a standing advertisement for help wanted in every paper in the country, and then could not get enough. Today there are upwards of 100 applications on our waiting list. Last year, with 60 people less on our pay roll, we did a business of $20,000 more than the year before."

Of course the returns are not directly measurable. To be sure they ultimately show up in the balance sheet, but not always in recognizable items. They appear in a more happy and contented corps of workers, and in a consequently cheapened production by reason of the better quality and increased quantity of the output; in an absence of strikes and labor disturbances; in greater interest in the business; in an increased personal loyalty; and in a dozen other ways, all tending to greater economy of operation in the establishment. The testimony on this point is indisputable, and amounts to this: However much it means in the sum total of civilization to have a community of cheerful, intelligent and virtuous operatives, it means a great deal more to the employer himself in the way of economic output and increased profits. That is to say, *it does pay.*

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* Mr. John H. Patterson, of the National Cash Register Co.

† Mr. S. W. Williams, of the Sherwin-Williams Paint Co.

It is doubtless true that many, possibly even a large majority of employers, still look askance or with disfavor upon any attempt to introduce into business any features not immediately essential to its prosecution. To them "business is business" continues to be the prime axiom, with which "altruism" is irreconcilable; and they keep themselves in countenance with the reflection that all such schemes are paternalistic and therefore unacceptable to the working men themselves, as well as ethically unsound. In recent years, however, there have been so many experiments in applying altruism to business, and these so uniformly successful when attempted in a rational and moral spirit, that the practicability of sane "welfare" work among and for employees is not open to legitimate question. Indeed, it is beginning to look as if we were coming to the point where a business, in order to be continuously successful, will necessarily become thus moralized, whether the owner wishes it or not, because of the necessity for satisfactory conditions and environment as a means of retaining a desirable class of employees, such as are essential to effective competition. Such workers naturally prefer to perform their tasks under the most desirable conditions, and quietly drift out of those shops where there is evidently little thought for human beings, and into those other shops where the spirit of "the square deal" prevails.

The new industrial revolution has progressed far enough to assure workers of their power, and to point to the employer the folly of disregarding plain moral obligations toward them. There are still a great many employers who manage their businesses with the least possible consideration for the work people, who nevertheless declare themselves able to keep an adequate supply of labor; but it is a significant circumstance, to say the least, that it is this class of employers, almost exclusively, who are in more or less constant conflict with labor. From them too comes the cry that is just now so insistent for more efficient workers. *Efficiency in workers goes hand in hand with sanity in employers.*

AUTOMOBILE ENGINES CONSIDERED FROM THE OPERATIVE POINT OF VIEW.

By Rodolphe Mathot.

Mr. Mathot is widely known on the Continent, and indeed internationally, as one of the leading specialists in the design and construction of internal-combustion engines. In the study here presented he demonstrates the interesting and important points which have been definitely settled in practical experience with the larger machines but which many builders of the smaller units have overlooked or ignored, to their own serious disadvantage. —The Editors.

THE latest automobile exhibit at Paris, and that which after a splendid success has just closed its doors at Brussels, have shown that so far as construction is concerned, one can no longer exactly speak of "bad" cars. The chassis as well as the engines, their transmission systems, and the accessories give proof of a veritable perfection in the manufacture and in the machining of the mechanical pieces.

Urged by the creating spirit, which has given such a strong impulse to automobile industry, these advances are due as much to the professional ability of our designers, as to the improvements which have been made in modern machine tools. Even metallurgy has found in the success of this mechanical industry a powerful stimulus, without which the absolute need of the manufacture of extra strong metals would not yet have manifested itself.

The systems of transmission seem to have been standardized, and aside from some exceptions, the chassis as well as the accessory parts tend toward fixed types.

But it is not the same with the engines, which, barring the vertical arrangement in front and the increase of the number of cylinders, seem to resist reduction to common rules as to form and principle. Designers seem in this respect to have thought more of making their engines run smoothly and regularly than of obtaining an economical output.

It may with reason be objected that the first named qualities are the most important ones in practice, and since the automobile is first of all an article of luxury, the question of economy can be of secondary importance only. But if this reasoning is correct when sport alone is considered, it cannot hold good when the automobile is looked upon from the point of view of utility, that is, as a means of rapid locomotion for passengers, of transporting heavy loads or of making parcel deliveries in cities, etc. There indeed lies the future of the automobile industry; success must be sought along this line, because there lies the field in which the automobile will have the most applications and the most new openings.

Thus to safe and steady running must be added economical operation, two qualities which seem to be the attributes of the most noble if not the most useful conquest of man. I believe the moment has come when designers must turn their attention upon the engine, in order to make it a more rational machine—that is, one more in harmony with the great scientific laws which seem to have been too much neglected in the development of automobile engines.

Is not the industrial gas engine, whose power and vitality are manifested daily in a manner that is perhaps too much ignored by our automobile designers, an interesting "ancestor" of the automobile engine? It is therefore well to remind them that alongside of the marvelous little engine which they have so skilfully applied to the new method of locomotion, there has developed a giant—the great gas engine, which has acquired the right to be mentioned concurrently with the old steam engines of our workshops, iron factories, etc., where it is represented by units of 100, 1,000, and even 3,000 horse power. One construction company has produced in four years about one hundred gas engines, representing a total of more than 100,000 horse power, which means an average of 1,000 horse power per unit. These large machines are fed either with poor gas which is produced in the plant itself in special gas producers, or with gas from blast-furnaces, coke ovens, etc.

Their gigantic aspect and their striking outlines hardly remind one of our little, graceful automobile engines, although they have the same essential parts.

In short, if in the lapse of not quite five years nearly 400,000 horse power have been turned out in the form of powerful gas engines, it must be recognized that this is the fruit of almost forty years of long research and scientific study. All resources of pure and applied science were put to work. The laws of physics, the principles of chemistry, and the rules of mechanics, were brought to the aid of the scientific workers who have long since addressed themselves to the complex question of the internal-combustion engine. Nevertheless it was only by long stages that we reached the point at which we are arrived today—that is, at what may be termed a solution which is industrially satisfactory.

But our younger designers of high-speed engines ignore, or forget too easily, the dawn of the great discovery to which they have contributed but a small share in the form of the automobile engine. And it is for want of having followed more closely the genesis of the industrial engine, its evolution and development, that they often neglect to derive instruction from it. Therefore, it often happens that we see introduced into automobile engines certain designs and arrangements—sometimes new and sometimes highly elaborated—which have already been rejected or abandoned in the construction of industrial engines as being bad in practice or defective in theory. In order to avoid this we would wish that the designers of our interesting little motors might seek inspiration more freely in what has been done in the large engines. This suggests the following points to which consideration might well be given:—

1.—The shape of the cylinder heads or combustion chambers.

2.—The shape of the pistons.

3.—The method of distribution, the valves, etc.

Shape of Cylinder Heads.—The shape of the cylinder head of an explosive motor plays a part whose considerable importance is too often ignored or overlooked.

Internal-combustion motors are first of all thermal engines which transform into mechanical work the heat given off by the motive fluid. Considering that for every 100 thermal units produced in the engine by the combustion of the exploding mixture, 25 to 30 units only are transformed into useful work, the importance of making heroic attempts to recover the 70-75 per cent of heat lost will be recognized. Of the latter about 30 per cent are absorbed by the cooling water, which should maintain the cylinder at a temperature consistent with the necessity of oiling; 40-45 per cent are carried off by the products of combustion escaping into the atmosphere at high temperatures. All that could be regained from the heat lost by cooling, radiation, and discharge would raise the efficiency of the engine. Let us see how this can be effected.

The interchange of temperature between the fluid which acts in the cylinder and the cylinder walls depends upon several items:

1.—The surface and nature of the cylinder walls.

2.—The difference in temperature between the gases of combustion and those walls.

3.—The duration of their contact.

1.—Among the materials (all more or less good conductors of heat) employed in the manufacture of the engines or their head ends, the choice is practically limited to cast-iron and steel. There is then nothing to be gained here, whereas so far as concerns the surface of the cylinder-walls in contact with the hot gases large savings may be effected. The essential conditions would be that the head ends should present, with the largest possible volume, a minimum of interior surface.

The volume of the cylinder head depends on the compression, and cannot surpass 1/3 to 1/5 of the total volume of the cylinder; because the resulting temperatures, with high compressions, would be such as to produce premature explosions. As the capacity of the explosion chamber is fixed, the means of reducing the interior surface must be found in the form. The shape giving a minimum of interior surface would be a hemisphere. The bottom of the piston in the outer dead-center position will constitute the base of this geometrical volume. Also, to reduce to a minimum the cooling surface which it offers, it must be plane and not round.

The necessity of saving a favorable space for the valves and for their manipulation constitutes, it is true, an obstacle to the construction of explosion chambers like the ones just advocated. We will review the more or less complex forms which designers have been led to give to the head ends on account of mechanical reasons.

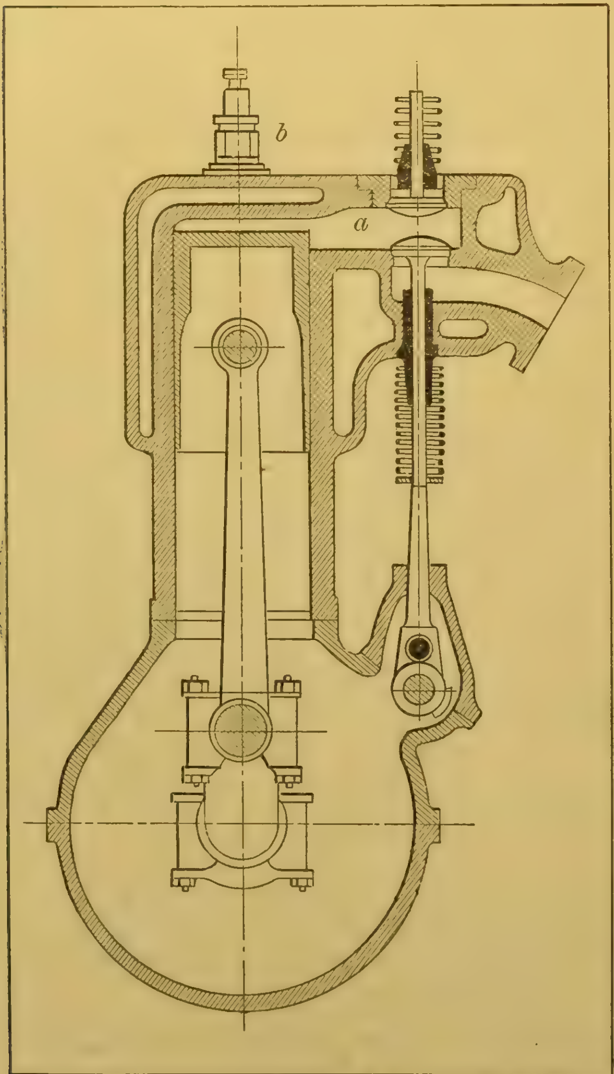

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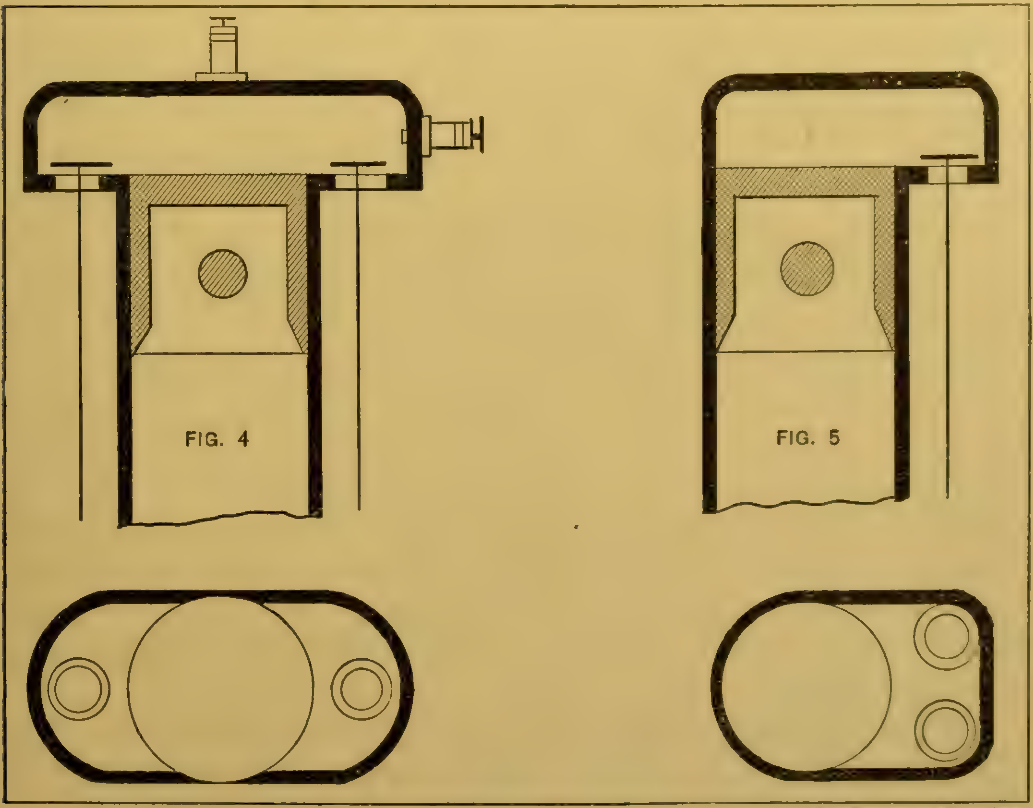
FIG. I. DE DION TYPE CYLINDER AND VALVES.

The most ancient and most widely accepted form is the De Dion engine, which constitutes a classical type having the free gas-inlet valve mounted above and in the same axis as the exit valve. (Figure 1). The explosion chamber is formed by the extension of the cylinder and by the recess in which the valves operate. Of the various forms of cylinder heads that we shall consider, it is perhaps the one which from a morphological point of view is the least in contradiction to the principles enunciated. The sort of antechamber formed by the lateral part produces, it is true, an additional surface in contact with the gases; but on account of the position of the inlet valve, the fresh gas bathes the outlet valve at each admission, this being most favorable to the cooling of the latter. The portion of the flame or ignition contrivance in (a) or still better in (b) assures a constant "washing" of the electrical contacts, by the gas charges. Also the products of combustion are expelled as thoroughly as possible after each explosion, thanks to the favorable form of this head end.

The positively operated inlet valve gave rise to a different type derived from the first Figure 4). This type of head end has the valves placed opposite to each other in two symmetrical positions.



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FIGS. 4 AND 5. HEAD ENDS WITH POSITIVELY OPERATED VALVES.

The ignition contacts are placed either in the admission space or in the bottom of the cylinder head. In this case the cooling surface is certainly carried to a point most harmful to the output. Furthermore, if this form has the merit of symmetry and as a consequence of interchangeability of the valves, it is evident that as regards the expulsion of the products of combustion, it cannot be very satisfactory. It offers to a part of the gases at the time of exhausting a lodging place in the admission space where they remain confined until they mix with the charge of fresh gas. Their presence contaminates and decreases the volume admitted to the cylinders.

It will be seen also that this form of complex head end is less favorable to the propagation of the flame, because the gases run, during combustion, uselessly against the angles and crevices which such a head end presents, this being detrimental to the realization of a maximum force on the piston. From the mechanical point of view this effect can be compared to that which the explosion of a charge of powder would have on the projectile of a cannon if that charge were in a breech located at the side and not in line with the axis, rather than exploding directly behind the projectile. In practice the projectile and the powder charge are to the cannon what the piston and the gas compressed in the head end are to the engine.

From a physical point of view, that is considering the velocity of propagation of the flame in the exploding mixture, I will venture to state once more this perhaps trivial comparison, which however fixes the ideas well.

The exploding mixture, a vapor each particle of which is surrounded by air, may perhaps be compared to a package of gun-cotton made up of a porous mass having each fibre surrounded by air and therefore forming a very powerful combustible. Supposing that the package of gun-cotton had a form similar to the space in which the gas is compressed, and that it be ignited at one extremity (a) ; it can be imagined that combustion will be the less rapid and less complete in a given time the more tortuous the path over which the flame has to travel in order to attain all the parts to be consumed. On the contrary, the burning or propagation of the flame will be the more rapid, the more compact the package of gun-cotton and the nearer to its center it is lighted.

This is absolutely what occurs with the exploding mixture in the head end of the engine. In this respect the head end having the two valves next to each other in one chamber (Figure 5) will be perhaps less unfavorable, because a more homogeneous and more compact mixture can be formed in an enclosure presenting less cooling surface.

Hence to approach the ideal theoretical conditions it would be necessary to make a hemispherical head end or explosion chamber, as was mentioned at the beginning of this paper. But this form cannot be obtained perfectly on account of the placing of the valves. A lucky attempt has, however, been made in this line by the firm Pipe, who have manufactured an engine in which the two valves have their valve stems converging toward the center of the cylinder head (Figure 6).

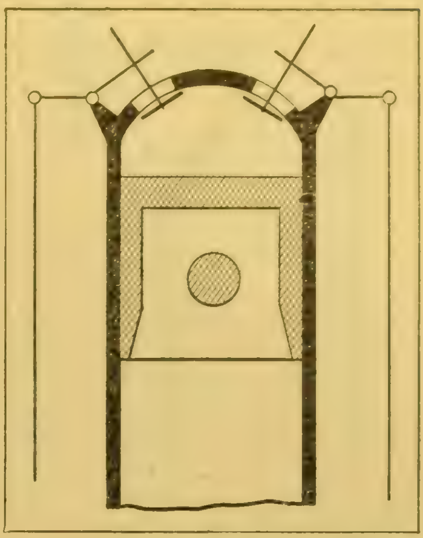

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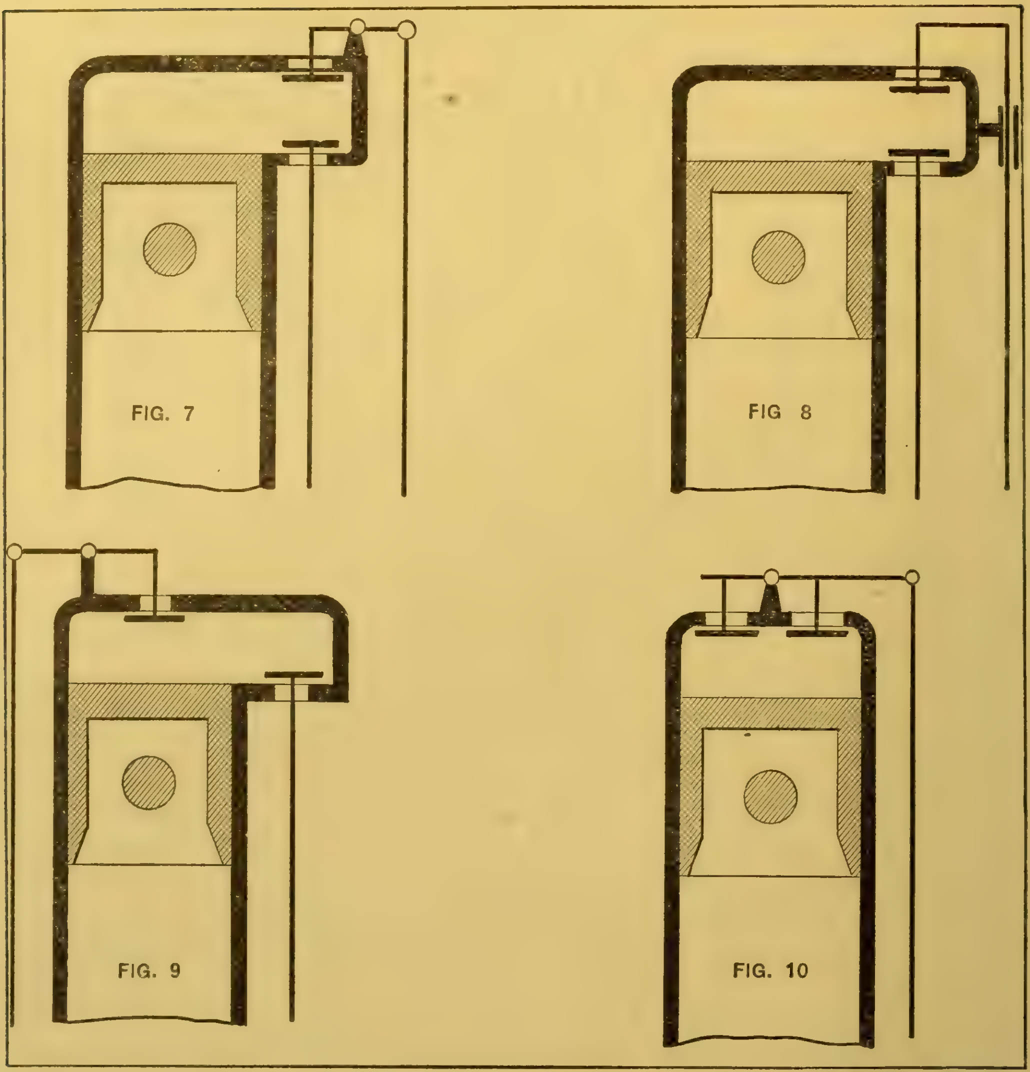
FIG. 6. HEAD END WITH RADIALLY DISPOSED VALVES.

To have a perfect arrangement, it ought to be possible to make the valve-disks flush, so that there would not be any projecting nor retreating parts in the cylinder. As far as operation goes, the mechanism and the proper proportions of the valves are also a preponderating element. An inlet or exhaust valve furnishing an insufficient passage to admit or exhaust the gases would cause a harmful resistance to admission or exhausting.

The inlet valve, if it is automatic—that is to say, held on its seat by a spring—will present a large area, and produce a sufficient passage by a small rise. It will therefore lift easily as soon as it is made to do so by the vacuum which the piston produces behind it during the admission stroke. As the inertia of the valve might diminish the free play of its spring, this valve should be as light as possible and the spring must have the minimum tension sufficient to bring the valve rapidly to its seat the minute the period of admission is over.

The automatic valve opens when the piston is sufficiently displaced to produce a strong enough suction. Hence the valve will give passage to the gas only when the stroke of the piston has commenced. In the same way the valve is brought back onto its seat by the spring before the suction stroke is completed. Therefore a whole cylinder full of gas is not introduced.

Theoretically, the valve ought to open as soon as the stroke begins, and close only at the end of the stroke, in order to fill the cylinder completely with the gas drawn in. This result is partially obtained by the mechanically operated admission valve, the opening and closing of which is regulated mechanically and depends on the position of the



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FIGS. 7, 8, 9, 10. VARIOUS MODES OF ARRANGING INLET VALVES.

piston. I say "partially," because the necessity of creating a relative vacuum in the cylinder to draw the air in and to accomplish its carburation, evidently prevents us from filling it with gas at atmospheric pressure. Such a condition would be realized only if the gas entered the cylinder under pressure, as is approximately the case with engines working with city gas. From this must be deduced that the mechanically operated inlet valve is not the ideal, and that it does not considerably increase the useful work of automobile engines. It has at any rate the undeniable advantage of making the running of them more elastic, and especially of letting them run regularly at slower speeds.

The regulating of the inlet valves can however be done in a great variety of ways. Some methods are shown diagramatically in Figures 7, 8, 9 and 10.

A good number of reputable designers consider that the advantages of the mechanically controlled valve do not compensate for its mechanical complication, and they stand by the well proportioned automatic valve. Others have adopted the mean of both methods by using a mechanical arrangement by which the valve is lifted from its seat at the precise instant at which suction commences. After all, this arrangement has the complications of the mechanically controlled valve without giving all the advantages.

Governing.—Governing the speed—that is to say, the number of revolutions of the engine as regards to the work which it has to do—was obtained some years ago by means of what is termed "throttling the exhaust." To effect this a centrifugal or inertia governor severed the connection between the exhaust valve and its controlling valve-rod as soon as the engine surpassed a pre-determined speed limit. This valve then remained closed during the course of several consecutive cycles, in which the piston, instead of sucking in fresh gas, only expanded and compressed the products of combustion that had remained in the cylinder. As soon as the speed had decreased sufficiently for want of moving impulses, the governor ceased to act, the connection between the exhaust valve and its controller re-established itself, and the explosions again succeeded each other. This method of governing consisted therefore in momentarily stopping the explosions. It presented the inconvenience of making the engine work by jerks.

For this has been substituted the regulation called "by admission," which consists, for engines with free valves, of making the governor act on a butterfly valve or a sort of slide valve which throttles the gas passage more or less, and is inserted in the gas-inlet pipe, between the carburettor and the engine. In this fashion the gas flow is regulated and depends on the speed at which the engine runs. The explosions are thus produced without interruption, but they vary in intensity, according as the governor admits charges of greater or less density. This process is more economical and strains the engine less because the jerks are suppressed.

It has been still further improved in engines supplied with mechanically operated inlet valves, by arranging the controlling contrivance so that the moment and duration of the stroke of the inlet valves is varied by means of the governor, and so more or less gas is admitted and the quantity regulated according to the number of revolutions.

As nothing positive exists on the subject of regulation, many designers (and among them not the least competent) have renounced the use of a governor pure and simple and replaced this automatic apparatus by an arrangement worked either by hand or by foot.

It must be observed that if the governor is indispensable in industrial engines, which run at constant speed and which must maintain it of themselves, it is hardly so with automobile engines, whose speed varies immensely and which are never left to themselves.

Exhausting.—We have examined the part played by the admission and the conditions which must be realized. Let us examine the exhaust, in which the details of operation have not less importance.

It is to be remarked that the exhaust valve is exposed to particularly high temperatures, especially during discharge, because then it is literally bathed in the inflamed gases which escape from the cylinder. It cools only when in contact with its seat, which is moreover very narrow and with which it is in contact only during the three consecutive parts of the cycle—namely, suction, compression, and explosion. Therefore the seat must be abundantly cooled by water circulation, and the jacket in which the water circulates should surround it equally well on all sides.

Whatever the form of the engine, the cooling water should enter the jacket in the neighborhood of the seat in order to cool it more thoroughly.

The valve proper must have a sufficient stroke to present a large outlet to the burning exhaust gases, first because if these were "throttled" a sort of rolling between the walls of the valve disk and the seat would occur; the gases would not fail to raise the temperature and to deform both of them; secondly because all resistance to the exhausting of the gases is harmful to the efficiency of the engine.

Resistance to exhausting produces a back-pressure, which absorbs useful work (to the detriment of the engine), behind the piston at the moment of its return motion—that is to say, during the time when it ought to be entirely free. This resistance must therefore be fought by all possible means.

Independently of the effect of the rolling of the valve there exist several causes of back pressure which we may examine.

The insufficient size of the section or the exaggerated length of the exhaust pipes is one of the first causes; to point out the defect is to indicate the remedy. Therefore pipes should have at their origin a section at least equal to that of the exhaust valve, and this should be increased as soon as the arrangement of the parts of the engine located in the immediate neighborhood will permit it.

The mufflers which terminate the exhaust pipe, with a view of deadening noise, should be mounted as near as possible to the engine.

In engines of more than one cylinder, the form of the collecting tube which receives the discharges at the exhausts of the different cylinders must be judiciously determined, so that each cylinder is provided with its proper exhaust pipe leading to the common muffler.

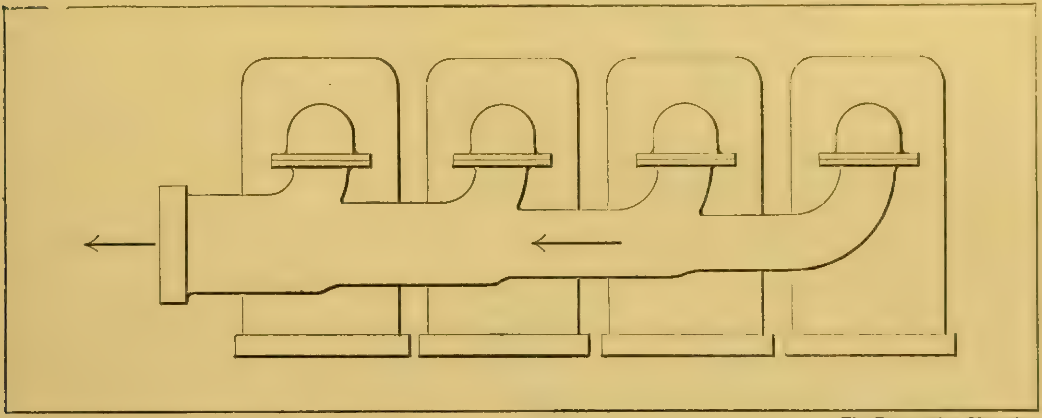

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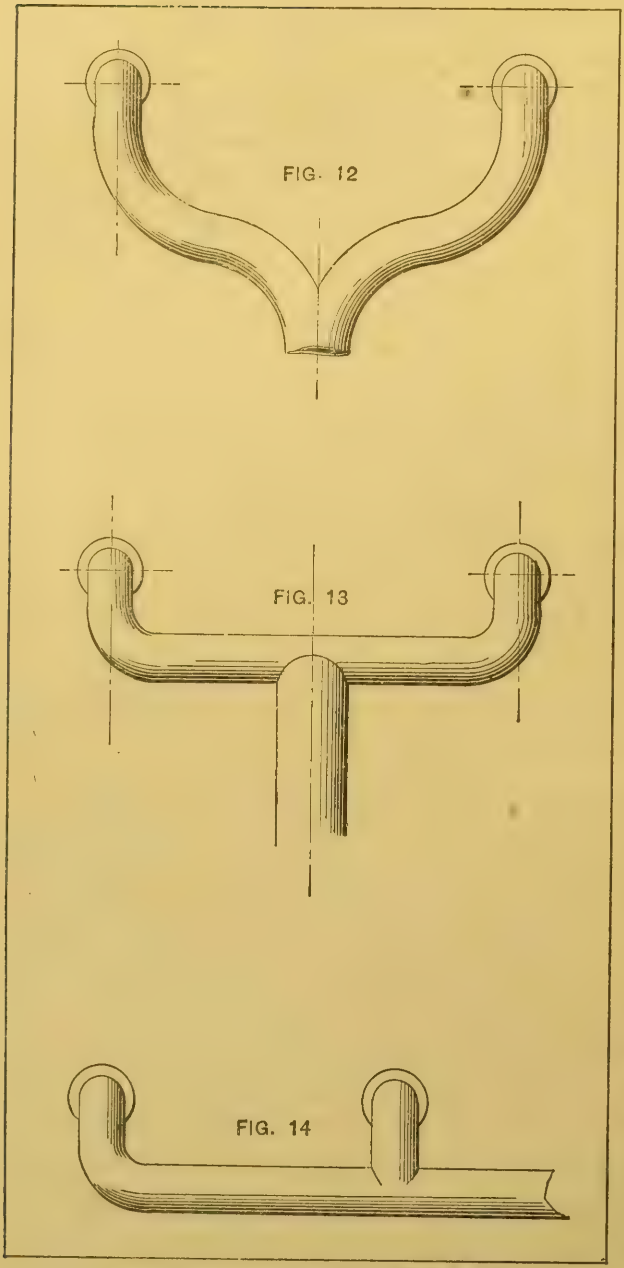
FIG. II. EXHAUST TUBE SUCCESSIVELY ENLARGED IN SECTION AS THE EXHAUST FROM EACH ADDITIONAL CYLINDER ENTERS.

The section of this collector tube must increase as the different exhaust tubes branch into it. (Figure 11.) These branchings should be made of such profile that the gases can readily be expelled (Figure 12), because if they were made perpendicular to the exit, the gases thrown with a high velocity against the walls of the collector would form eddies that would hinder expulsion (Figures 13 and 14).

As the products of combustion leave the cylinder they occupy an excessive volume on account of their high temperatures. If instead of having a temperature of 600 to 800 degrees, they could be lowered to a temperature of about 100 degrees, their volume could be reduced more than one-half and a pipe section one-half less would suffice to expel the same quantity. It would therefore be of evident interest to cool the exhaust.

Some designers have understood this very well. They have placed cast-iron radiator rings or disks on the collector tube, which have the effect of increasing its cooling surface. It would be necessary to improve on this and to extend the water circulation to one part of the collector the same as it is extended on one part of the exhaust tube at the place where it comes out of the cylinder.

In large industrial motors we return moreover to the use of a positive water circulation around the lower part of the exhaust pipe, which serves as much to cool the gases as to prevent the excess of



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FIGS. 12, 13, 14. CORRECT AND INCORRECT PROFILES FOR EXHAUST PIPE CONNECTIONS.

heat which the pipe would release into the engine room.

In spite of the precautions that may be taken to fight the resistance to the exhausting of the products of combustion, the use of the muffler unfortunately annihilates them in part.

This discharge pot (or as the chauffeur calls it, the "muffler") serves to deaden the noise of the exhaust. But this deadening is obtained only to the detriment of the free emission of the exhaust gases. The noise is muffled by making the gases pass through chambers and recesses arranged in the muffler. Also, the more that the noise has been deadened, the more can it be said that harm has been done to the power of the engine. It is therefore to the disadvantage of the high efficiency of the engine that the chauffeur gives to the public this legitimate satisfaction, which consists in not deafening it by the sonorous puffing of his machine.

Use efficient mufflers, then, in the city and in inhabitated places, but dispose of them by one turn of the hand when in the country and in the plain where you will harm no one.

Crank Shafts.—The question of crank shafts increases in importance with the increase of the number of cylinders. The working of a single-cylinder engine would be very unsatisfactory if the crank were not balanced by placing counterweights on the cheek plate or on the disks which take the place of the crank arm, in order to compensate the weight of the crank and part of the moving connecting rod. As concerning the two-throw crank of two-cylinder engines, it is well to rectify at this opportunity a very widespread error, which consists in considering the crank as in equilibrium itself.

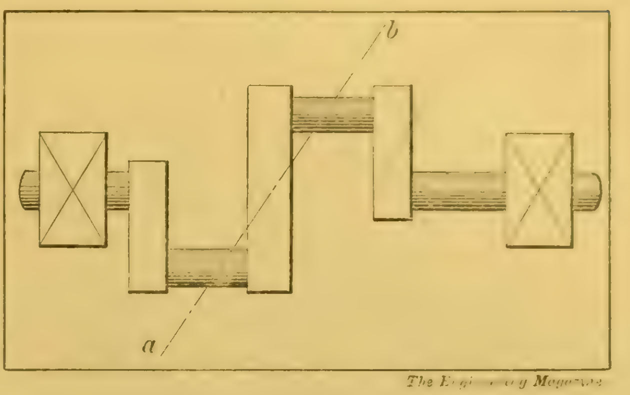


FIG. 15. SHOWING AXIS OF ROTATION SOUGHT BY REVOLVING TWO-CRANK SHAFT.

It is quite true that it is in equilibrium in the static condition—that is to say, as it is tried by the workshop methods, which consist in balancing it on knife edges and regulating it in such a manner that it remains stationary in all positions; but it is never so in the dynamic state—that is to say, when in motion. As a matter of fact, in these conditions the two cranks tend to straighten up and try to place themselves in an axis of rotation (a b) passing through their centers of gravity (Figure 15).

A similar phenomenon shows itself in a more conspicuous manner in the grindstones of the miller, for instance. It is known that the upper one of these stones rotates about a vertical axis passing through its center. Now it may happen that the stone will have holes on the surface finished for the grinding. These holes are filled with a special cement, which is very compact and which the miller uses for these repairs (Figure 16). But this cement acting like a counterweight will bring the stone out of equilibrium and make it hang to one side at (a). Equilibrium may be reestablished by pouring in lead at the part diametrically opposite (b) but in spite of the equilibrium thus established it will be soon noticed by the work that the stone wears off at

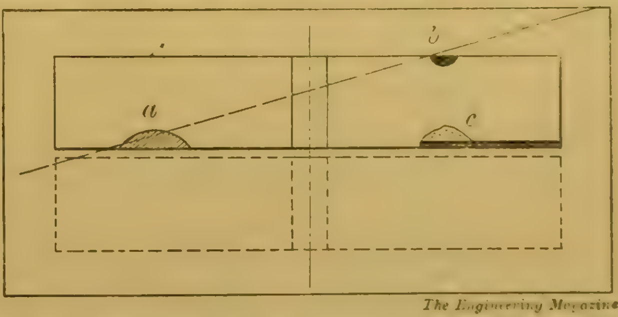
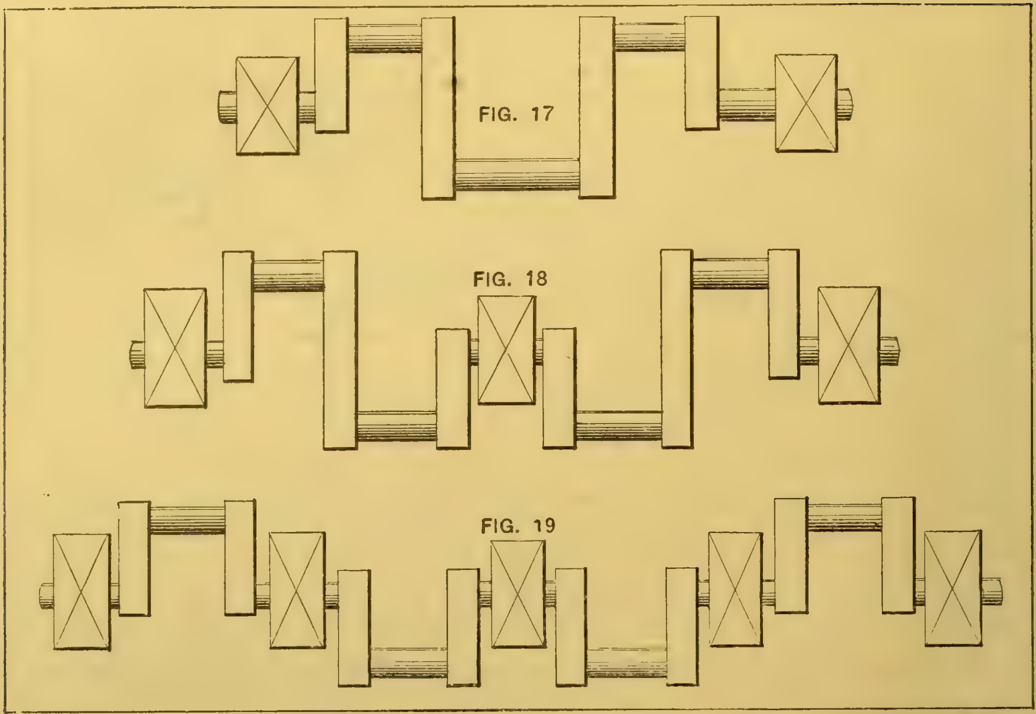


FIG. 16. EFFECTS OF COUNTERBALANCE ON AXIS OF ROTATION OF A MILLSTONE.



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FIGS. 17, 18, 19. VARIOUS METHODS OF DISPOSING THE JOURNALS OF THREE-CRANK AND FOUR-CRANK SHAFTS.

(c), which goes to show its tendency to lean some more to that side. In reality the stone seeks to turn according to its centrifugal force, that is in a plane (a b) which tends to become perpendicular to the axis of rotation.

To put the stone in dynamic equilibrium the mass of lead would have to be poured in at (c).

This case is comparable to that of a double-throw crank, and shows that for equilibrium of the latter, each crank must be counterbalanced by a weight placed at the opposite end of the crank arm.

There is no reason to observe the same precautions for the crank shafts of a four-cylinder engine. Formerly they were constructed with three cranks, the two connecting-rods of the central cylinders being attached to the middle crank (Figure 17). To support properly the shaft (which had journals at the extremities only) a quadruple crank with inside journals is now made (Figure 18). With a view to solidity, certain designers have even placed each crank between two bearings, so that there were five bearings to the shaft (Figure 19). Here we have perhaps an excess of precaution. In this case there is an increase of bearing friction, which is more serious in my opinion than the vague eventualities of breakage of the shaft.

AN ELECTRIC POWER PLANT IN THE WEST INDIES.

By Percival Robert Moses.

While The Engineering Magazine does not generally publish papers relating to the installation of specific equipments, it has seemed in this case that a complete summary of the problem presented, its solution, the installation of the equipment, and the operation after completion, would be of interest, particularly as the work had to be carried out in a newly developing country under conditions differing from those existing at home.

THE problem presented by the power plant described in the following pages was somewhat complex: A sugar mill was to be erected in a West India Island, and electric power was to be supplied to the mill for operating a quantity of machinery; but this was not to be the main work of the plant. The country around this particular mill was arid and irrigation necessary. Water for irrigation was to be obtained from driven wells grouped together at various points, 60 or 100 to a group; the maximum distance from the sugar mill to the farthest group of wells being approximately 7 miles. Besides the power for irrigation and power for the sugar mill, it was also necessary to provide lighting for a small village and for the mill.

The property was situated on a deep-water bay, and the mill was to be located close to the shore. Coal cost in the neighborhood of $7 a ton delivered. There were several ways of solving the problem, and the first matter to be settled was whether it was better to use a central station close to the sugar mill, and to distribute power for pumping electrically, or to install separate steam pumping plants at each group of wells, and a separate electric plant for the sugar mill proper. A central station located close to the sugar mill was decided upon, with electric-driven pumps at each group of wells, because estimates showed that the cost of pumping, using separate steam pumps, including the cost of separate labor force at each pumping station, was more than double the cost of using the central station; the relative and estimated costs being $59,000 with compound condensing pumps as compared with $26,000 using electric-driven pumps. The estimated and initial cost of the electric transmission plan was about $50,000 more than with the separate plants.

The various types of electric pumps were considered, and the rotary pump having lobed impellers was determined upon as the best. The reasons for this choice were that water for irrigation had to be pumped against heads varying from 80 to 200 feet; this put the centrifugal pump out of the running on account of its comparatively low efficiency against high heads; the triplex pump was abandoned on account of its lack of simplicity and the danger of scoring and wearing of pistons and cylinders through sand being drawn up from the wells. The rotary pumps purchased had a guaranteed efficiency of 80 per cent; that is to say, 80 per cent of the power delivered to the motor was to be shown in the water pumped; and they were further guaranteed to draw from anything up to 30 feet. This was accomplished by keeping the clearance of the impellers very small. This type of pump lends itself very readily to electric drive.

To take care of the various electrical requirements in the best manner, three voltages and currents were chosen. For electric pumping for irrigation, 6,600-volts, three-phase, alternating-current system was adopted, this voltage being generated directly at the dynamos, carried out on the line, and transformed down to 220 volts before entering the motors at each pumping station.

For lighting the village and surrounding district, alternating current at 240 volts on the three-wire system was used in order to reduce the cost of wiring.

For factory power and lighting, electricity was supplied at 120 volts, direct-current; this voltage and current being chosen in preference to the 240-volt direct-current system for the reasons stated in a previous article (The Engineering Magazine, September, 1904). The direct-current system was chosen in preference to the alternating-current system for the reasons stated in the same article, viz., the lower first cost, and advantages in speed control and crane work.

It was decided to run the plant condensing, using salt water from the bay, on account of the high cost of coal, and the fact that the sugar mill would not only be able to supply its own steam, we were informed, from the bagasse or refuse sugar cane, but would also have surplus steam to supply to the power plant; hence the exhaust steam from the electric engines could not be used. High cost of coal also made it imperative to save in every way, so a Green fuel economizer was installed, and a compound high-efficiency air pump and circulating pump used. As the water for boiler purposes was not of a good quality, it seemed bettter to install a surface condenser, saving the condensed water and returning it to the boilers. To do this, a special arrangement for gettting rid of the oil was necessary, consisting of a baffle-plate grease separator in the exhaust line draining to a tank with equalizing pipe and surface blow from the tank, hand-operated, arranged to blow off oil at frequent intervals. No trouble whatever has been experienced from oil in the three years of the plant's operation, and the system is one that should be of value in every condensing plant where the feed water is expensive or of poor quality.

It was also decided not to let one general contract, but to make individual contracts with all the manufacturers of apparatus; to employ erecting men directly, and to erect the work ourselves; this being evidently the most economical method of handling such equipment. Thirty separate contracts were made, the largest being the electrical contract, including all the electric apparatus, except line material and some motors; and the smallest, intercommunicating telephone system amounting to $170. The contracts included: power house, boilers, engines, dynamos, rotary converters for delivering direct current to the sugar mill, induction motors for pumping stations, transformers, air and circulating pump, eleven miles line material, poles; boiler-feed pumps, steam auxiliary apparatus, such as heaters and separators, eight rotary pumps varying from 1,000,000 to 4,000,000 gallons per day capacity, smoke stack 5 feet diameter by 150 feet high, auxiliary steam piping, two small kerosene engines, and a quantity of small material.

The complete equipment as planned and installed consisted of three boilers with space for a fourth, which has since been installed, two compound condensing engines belted to 6,600-volt, three-phase dynamos, two rotary converters arranged to be driven either electrically by alternating current, or by belt from a non-condensing steam engine. The usual auxiliary apparatus installed included feed-water heater, feed-water filter, economizer, grease extractor, surface condenser, etc. The power house was built of steel with galvanized-iron sides and roof, the floor of the engine room being kept 5 feet above the ground, the boiler-room floor being level with the ground.

With this combination of rotaries and alternating-current dynamos, the three electrical systems can be obtained. When irrigation is required, which is for eight or nine months of the year, the large alternating-current dynamos and the high-efficiency engines are run supplying the pumping stations directly, and the factory mill indirectly through the rotary transformers. At slack seasons, when the irrigation plant is not in operation, the rotaries can be run as dynamos directly from the small engine and all three forms of current can be obtained from them, the same as from the large alternating-current dynamos, except that the small quantity of high-voltage alternating current which may be needed for irrigation, and the lower-voltage alternating current for lighting, are obtained indirectly through transformers, and the mill requirements are supplied directly from the direct-current side of the rotary transformer. In order to avoid trouble with rotaries, the 25-cycle three-phase alternating current was used, and this has no bad effect on the lighting, as there are no arc lights.

The full plant as completed has a capacity of 1,000 boiler horse power with a maximum continuous operating capacity of 850 kilowatts.

Some figures on the cost per horse power or kilowatt f. o. b. New York will be of interest in this connection, as the prices have not changed materially:

Boilers	$14.00	per horse power
These are a special type with steel sides suitably insulated, chosen on account of the trouble of getting competent masons.		
Compound condensing engines	$17.00	per horse power
Alternating-current dynamos	15.00	“ kilowatt
Rotary converters	25.00	“ “
Induction motors	22.00	“ horse power
Transformers	16.00	“ kilowatt
Air and circulating pump and condenser	7.00	“ horse power
Line material	375.00	“ mile
This is exclusive of poles, which cost about $350 per mile additional. The poles had to be sent down from the United States and were treated with creosote to preserve them.		
Boiler-feed pumps, feed-water heater, and other steam auxiliary apparatus, including piping	6.00	per horse power
Smoke stack, about	2.50	“ “ “
Economizer	2.50	“ “ “
Switchboard, exclusive of boards in pumping stations	4.00	“ kilowatt

Rotary pumps, about $500 per million-gallons capacity, exclusive of motors, or inclusive of motors, about $1,000 per million gallons capacity.

Power house, exclusive of common labor and freight, $23 per kilowatt capacity.

This was high on account of the short delivery required, the ordinary delivery costing about $20 per kilowatt.

The plans and specification covered standard apparatus somewhat modified to meet the conditions of a semi-tropical climate; this applies more particularly to the condenser and to the electrical machinery, the allowable rise in temperature of the electrical machinery being reduced to 35 degrees C; and the condenser surface increased to provide for warm condensing water. The plans had to be somewhat more accurate than the usual plan made out for bids, as all the piping had to be cut to measure and sent down ready for erection. As the steam pressure carried was to be 150 pounds, the steam piping was all made up with flanged joints, the pipe being first screwed into the flanged edge of the pipe, peened against the edge of the flange, and the whole placed in a lathe and the face of the flange trued up; flanges were made male and female, with copper gaskets, and no trouble has been experienced with leaks.

All the apparatus was inspected before shipment, and this is very necessary where material is to be sent a long distance. It is impossible to test large engines before shipment, but the process of manufacture and the completed product should be carefully inspected. All the large electric companies have very complete methods of testing, and the usual runs were made. The pumps were tested to determine capacity and inspected to see that the material and workmanship was proper, and were run under conditions as nearly as possible approximating those under which they would operate after erection. Most of the other apparatus was merely inspected before shipment, no test being possible, except such hydrostatic tests as are made on boilers, cylindrical tanks, and other similar apparatus.

The material was shipped as it became ready, power house first, boilers next, engines next, and then dynamos and all the electrical apparatus. The equipment was not fully completed until about a year after placing the contracts. There were a great many difficulties in the way of erection and shipments were slow. It was not possible to obtain competent boiler erectors, steamfitters, wiremen or other mechanics on the island, and all the skilled labor was sent down from the United States; common labor was all supplied on the ground. The usual rate of pay for common labor was 40 cents a day, and it was worth about this amount. The natives worked 12 hours and would walk from 5 to 10 miles each direction morning and night to and from work, before the railroad was built; but they would not carry more than a very small quantity of material, and when they did work, worked slowly and without intelligence. They would also, as soon as they had made a few days' pay, stop work and not show up for two or three days more. Gradually, by increasing the pay and picking the men, a proper gang of helpers for line work and other work was obtained. Besides sending down laborers, it was necessary to send down also all tools, as practically nothing could be purchased within a radius of 50 miles. What this means can hardly be appreciated by the man who has been accustomed to sending out to the nearest supply store for a wrench or a washer or anything else

LOG BLANK Monday

May 22nd 1905 DATE

	AMPERES			OUTGOING LINE				Exciter No. 1		Exciter No. 2		ROTARY No. 1				ROTARY No. 2				STEAM PLANT				
					AMPS PHASE															TEMPERATURE		STEAM PRESSURE		
TIME	GEN. No. 1	GEN. No. 2	GEN. No. 3	VOLTS	No. 1	No. 2	No. 3	VOLTS	AMPS	VOLTS	AMPS	A. C AMPS	AMPS FIELD	D. C. VOLTS	D. C. AMPS	A. C. AMPS	AMPS FIELD	D. C. VOLTS	D. C AMPS	F. W.	COND W.	HIGH	REC.	COND.
6^{00} A.M.	13.5	13.5		6600	27	27	27	119	50			4.	7.3	127	280							144	10	24
7 "	13.5	13.5		6600	27	27	27	118	45			3.5	7.	128	210							145	10	24
8 "	13.5	13.5		6600	27	27	27	118	45			3.5	7.	128	210							144	10	24
9 "	13.5	13.5		6600	27	27	27	118	45			3.5	7.	128	210							145	10	24
10 "	13.5	13.5		6600	27	27	27	118	45			3.5	7	128	210							142	10	24
11 "	13.5	13.5		6600	27	27	27	118	45			3.5	7	128	210							145	10	24
12 N.	13.5	13.5		6600	27	27	27	118	45			3.5	7	128	210							146	10	23.5
1 P.M.	13.5	13.5		6600	27	27	27	118	45							3	6.6	128	210			140	10	23.4
2 "	13.5	13.5		6600	27	27	27	118	45							3	6.6	128	230			140	10	23.
3 "	13.5	13.5		6600	27	27	27	118	45							3	6.6	128	230			144	10	23
4 "	13.5	13.5		6600	27	27	27	118	45							3	6.6	128	230			145	10	23.3
5 "	10.0	10		6600	20	20	20	118	51							3	6.6	128	230			146	9	23.6
6 "	11	11		6600	22	22	22	119	52							2.3	5.6	130	180			150	11	24
7 "	11	11		6600	22	22	22	120	84							2.3	5.6	128	180			140	11	24.
8 "	16.5	16.5		6600	33	33	33	120	84							3.6	5.4	128	280			150	12	23
9 "	16.5	16.5		6600	33	33	33	120	82							3.4	5.6	126	280			150	12	23
10 "	16	16		6600	32	32	32	120	82							3.	6	128	260			150	12	23
11 "	16	16		6600	32	32	32	120	82							3.2	6.1	126	260			150	12	23
12 "	16.5	16.5		6600	33	33	33	120	82							2.8	6.2	129	270			148	10	23
1 A.M.	16	16		6600	32	32	32	120	82							3.6	6.	127	240			150	12	23
2 "	16	16		6600	32	32	32	120	82							3.2	6	126	300			150	12	23
3 "	16	16		6600	32	32	32	120	82							3.3	6.2	127	280			145	12	23
4 "	16	16		6600	32	32	32	120	82							3.4	6.2	126	280			150	12	23
5 "	16	16		6600	32	32	32	120	82							3.5	6.4	127	300			150	12	23

REMARKS

Power House lighting supplied by Exciter
House & Office lighting and lighting on 1st & 2nd floors of Factory; supplied by 40 K.W. Transformer.

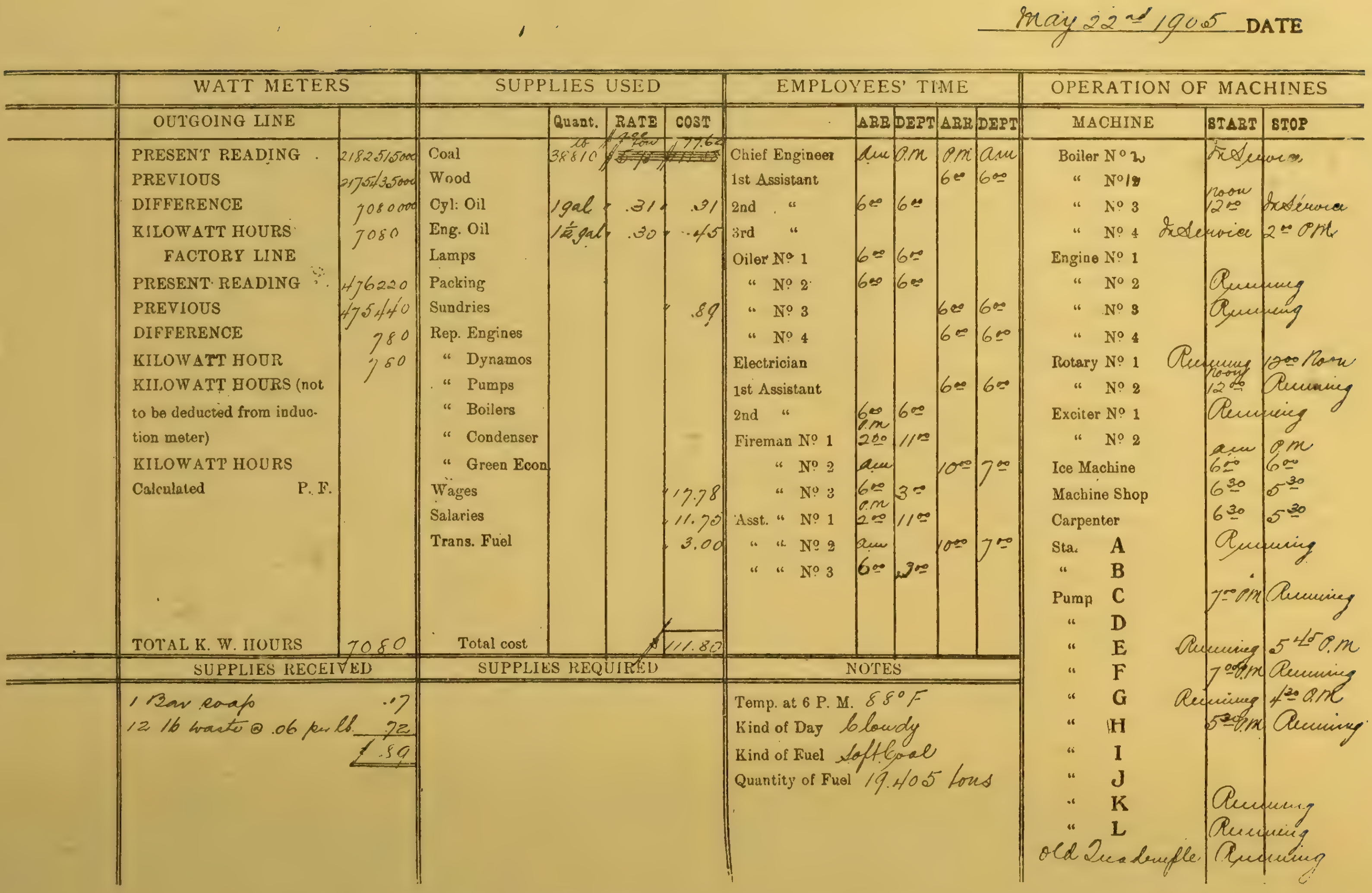
EXAMPLE OF DAILY LOG BLANK, AS FILLED OUT IN SERVICE.

that he may want. Heavy rains made the roads impassable, wagons sinking up to their hubs in the mud, and no labor was obtainable nor work possible during these times. The rainy season is short, lasting only a few months, but when it does come, the whole country becomes a floating mass of mud, making transportation of heavy machinery impossible. A statement showing the distribution of labor on the different parts of the work, and the condition of erection was forwarded weekly, on regular blanks itemizing the chief individual features of the work, and requiring only brief manuscript entries. As comparatively few of the blanks were necessary, they were prepared by manifolding a type-written form. These reports were supplemented by a letter and by requisitions for supplies.

Shortly after the commencement of the work of erection, a hotel was completed in which the men from the States could find room to sleep and in which meals were served. There was a great deal of difficulty in getting proper provisions, and everything had to be imported, as not even milk or butter was obtainable, and a few of the men became dissatisfied with the conditions and left; but in general there was but little trouble on this score, and none from disease.

The chief trouble experienced with the men from the States was drunkenness, and it is of the highest importance in choosing men to send out on such work where they are away from control, to be sure that they do not drink to excess. In order to get such men it is necessary to pay good wages, as they can make good money at home. The wages paid on this work varied from $200 a month for the head man to $150 and $125 a month for his assistants, and from $110 to $125 a month for first-class linemen and steam fitters. In all cases the traveling expenses were paid, and the men drew pay from the time of leaving the States. Their traveling expenses were also paid going back, provided they had given satisfaction and remained until the work was completed. They were given lodging, but paid for their board at $4 or $5 a week. If they were discharged for incompetency or drunkenness, or if they left without being discharged, they did not receive any traveling expenses home. After completion of the erection the force was re-organized as follows:

1 Chief Engineer
2 Assistant Engineers
2 Electricians
4 Oilers
3 Firemen
3 Assistant Firemen
Servant
Telephone Boy
7 Peons for transporting fuel.



May 22nd 1905 DATE

WATT METERS

OUTGOING LINE	
PRESENT READING	218251500
PREVIOUS	217543500
DIFFERENCE	708000
KILOWATT HOURS	7080
FACTORY LINE	
PRESENT READING	476220
PREVIOUS	475440
DIFFERENCE	780
KILOWATT HOUR	760
KILOWATT HOURS (not to be deducted from induction meter)	
KILOWATT HOURS Calculated P. F.	
TOTAL K. W. HOURS	7080

SUPPLIES USED

	Quant.	RATE	COST
Coal	lb 38810	$2.00 ton	77.62
Wood			
Cyl. Oil	1 gal	.31	.31
Eng. Oil	1½ gal	.30	.45
Lamps			
Packing			
Sundries			.89
Rep. Engines			
" Dynamos			
" Pumps			
" Boilers			
" Condenser			
" Green Econ			
Wages			17.78
Salaries			11.70
Trans. Fuel			3.00
Total cost			$111.80

EMPLOYEES' TIME

	ARR	DEPT	ARR	DEPT
Chief Engineer	a.m.	p.m.	p.m.	a.m.
1st Assistant			6^{00}	6^{00}
2nd "	6^{00}	6^{00}		
3rd "				
Oiler Nº 1	6^{00}	6^{00}		
" Nº 2	6^{00}	6^{00}		
" Nº 3			6^{00}	6^{00}
" Nº 4			6^{00}	6^{00}
Electrician				
1st Assistant			6^{00}	6^{00}
2nd "	6^{00}	6^{00}		
Fireman Nº 1	p.m. 2^{00}	11^{00}		
" Nº 2	a.m.		10^{00}	7^{00}
" Nº 3	6^{00}	3^{00}		
Asst. " Nº 1	p.m. 2^{00}	11^{00}		
" " Nº 2	a.m.		10^{00}	7^{00}
" " Nº 3	6^{00}	3^{00}		

OPERATION OF MACHINES

MACHINE	START	STOP
Boiler Nº 2	In Service	
" Nº 1		
" Nº 3	noon 12^{00}	In Service
" Nº 4	In Service	2^{00} P.M.
Engine Nº 1		
" Nº 2	Running	
" Nº 3	Running	
" Nº 4		
Rotary Nº 1	Running	12^{00} Noon
" Nº 2	Noon 12^{00}	Running
Exciter Nº 1	Running	
" Nº 2		
Ice Machine	a.m. 6^{00}	p.m. 6^{00}
Machine Shop	6^{30}	5^{30}
Carpenter	6^{30}	5^{30}
Sta. A	Running	
" B		
Pump C	7^{00} P.M.	Running
" D		
" E	Running	5^{45} P.M.
" F	7^{00} P.M.	Running
" G	Running	4^{30} A.M.
" H	5^{30} P.M.	Running
" I		
" J		
" K	Running	
" L	Running	
Old Quadruple	Running	

SUPPLIES RECEIVED

1 Bar soap	.17
12 lb waste @ .06 per lb.	.72
	1.89

SUPPLIES REQUIRED

NOTES

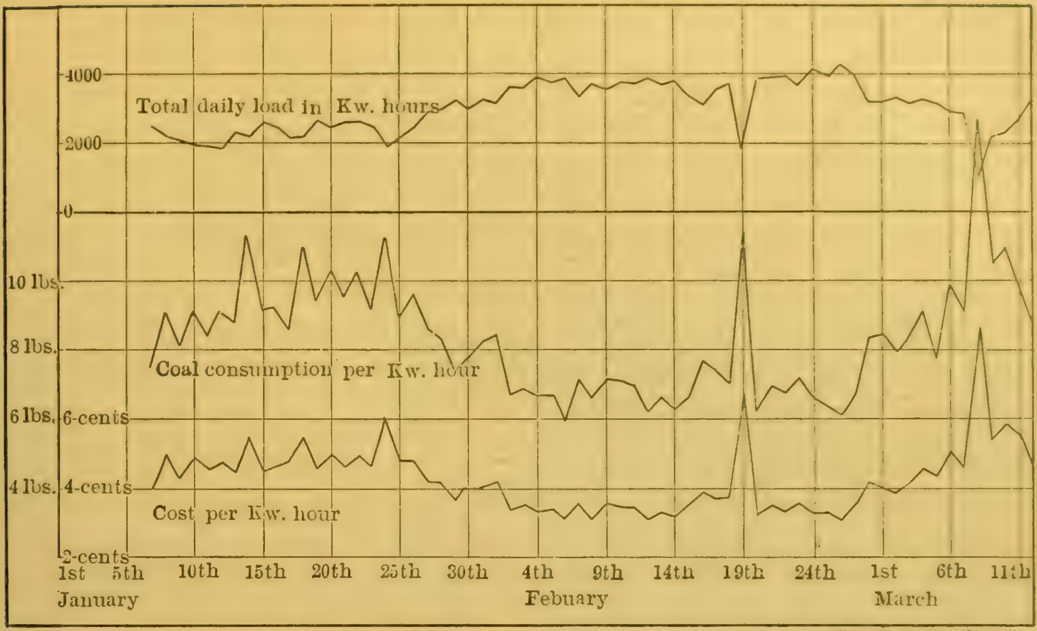
Temp. at 6 P. M. 88° F

Kind of Day Cloudy

Kind of Fuel Soft Coal

Quantity of Fuel 19.405 tons

EXAMPLE OF SUMMARY SHEET, COVERING FUEL, LABOR, SUPPLIES, AND OPERATION.



The Engineering Magazine

PART OF THE LOAD, FUEL-CONSUMPTION, AND TOTAL-COST CURVE.

All the men, except the chief engineer, his assistants, and electricians, were natives, and received from 25 cents a day for telephone boy to $1.20 a day for the better men. This force includes the day and night force, the plant running 24 hours a day.

In order to keep track of the operating expenses and results, a complete system of log blanks and reports was made up, samples of which are shown on pages 574 and 576. One set of logs shows the hourly supply of current and steam pressures, while the other shows the total quantity of electricity manufactured, its cost, times of arrival and departure of the force, and times of starting and stopping of the machinery, including the pumping stations; also notes as to supplies received and required, and temperatures, kind of fuel. etc. These results are plotted into a curve showing the cost per kilowatt hour for different total quantities of kilowatt hours. The minimum cost per kilowatt hour is 1.53 cents; the average cost about 2.5 cents; minimum coal per kilowatt hour is 4.4 pounds. During regular operation of the plant the maximum coal per kilowatt hour runs to as high as 12 pounds. These figures are for loads varying from 2,000 kilowatt hours per day to 7,000 kilowatt hours a day, or from one-third full load to full load.

The supply of steam from the sugar house has also been obtained, as originally intended, which further decreases the cost. This cost is at least 50 per cent greater than the cost would be in a similar plant in the States, as the coal costs about twice as much and the labor is more expensive as more of it has to be used. The coal cost forms nearly 35 per cent of the total operating cost. These costs do not include fixed charges on the investment, which add about 1½ cents per kilowatt, or a total cost of about 4 cents per kilowatt hour.

In estimating the fixed charges, the same rates that govern in the States have not been used, but an interest rate of 7 per cent, and a depreciation rate of 6 per cent, have been allowed, while the rates in the States should not be over 5 per cent in each case. These same rates were used in deciding originally as to the proper expenditure allowable for the increased efficiency, and no extra money was paid for increased efficiency in the apparatus, unless the increase showed at least 15 per cent on the investment.

The total efficiency of transmission from steam cylinders of the engines to the gear of the pumps is 54 per cent. The efficiencies of the various pieces of apparatus are about as follows:

Generators, full load 92 per cent; three-quarter load 90.5 per cent; half load 87 per cent.

Transformers, full load 97 per cent; three-quarter load 97 per cent; half load 96.5 per cent.

Pump Motors, full load 89 per cent; ¾ load 89 per cent; ½ load 87 per cent.

Pumps, full load 80 per cent; ¾ load 75 per cent; ½ load 75 per cent.

Rotaries, full load 91½ per cent; ¾ load 90 per cent; ½ load 85 per cent.

Transmission line, about 5 per cent loss at full load.

On this basis, the engines using 18 pounds of steam per horse-power hour at ¾ load, and 8 pounds steam evaporated per pound of coal, the coal per horse power of water pumped amounts to 4.1 pounds.

Very little trouble has been experienced with the operation of the plant, and the repairs have been normal. The total operating expense is within 10 per cent of that originally estimated, so that the economy of the electric transmission over the individual steam plants originally estimated may be taken as approximately correct.

EDITORIAL COMMENT

WHILE the country waits for the report of the Advisory Board on the Isthmian Canal, Congress is giving an interesting demonstration of the essential unfitness of a republican Government to carry out large works of construction. Four hundred minds, trained in engineering, and organized under a master in the profession, driving steadily toward one well-conceived, economic plan, would be an ideal force for successful achievement. But four hundred minds chiefly ignorant of the requirements and limitations of engineering work, and each inspired with a sense of independent sovereignty; an energetic minority of them merely obstructive, and the sympathetic majority almost at blows among themselves over irreconcilable differences of policy; the whole body moving stiffly and tardily, by a series of concessions toward a course of compromises—surely, no institution could be conceived less fitted to act with the promptness, the energy, the specialized knowledge, and the clear judgment necessary for the "economical direction of the sources of power in Nature for the benefit of mankind." The significant modification of Tredgold's definition, by the way, is Mr. Wallace's.

In brief, constructive enterprise is not one of the normal functions of the Government. It never has been happy in that field, as almost any one even of its minor undertakings will witness. The opportnnities for disappointment in the case of the Panama Canal are large in proportion to the difficulty of the work involved. It seems to be growing increasingly clear that while the magnitude and the surrounding conditions of the case manifestly indicated a Governmental acceptance of the task of "piercing the Isthmus," the functions of the Government should be only to see that the work is "well and truly" done—not actually and physically to do it. Here, as elsewhere, let the Government govern, wisely and honestly, as belongs to its sphere; and let practical constructors build, economically and effectively, as belongs to theirs. We believe that an adequate contracting organization, of the necessary high standards of moral and financial integrity, under the most searching Government supervision and in the highest light of publicity, will put through the construction with the utmost attainable economy of time and cost, and with a fraction only of the likelihood of scandal and bitterness of feeling involved in adherence to the method of direct Government execution. Such a contracting organization would justly command the services and the faith of the best engineering talent in the country. Under similar corporations, some of the highest engineering standings have been won, and no man would hesitate to trust his future or his character into such hands. Under direct political or departmental management, it has already been painfully proven that the most priceless possession of the engineer—his high professional reputation—is not safe.

* * *

AT the recent meeting of the American Society of Mechanical Engineers, in New York City, it was demonstrated, if any demonstration was necessary, that one good topical discussion is worth a dozen papers, both in respect of the valuable information elicited and in view of its success in interesting the members in each other's work. The discussion upon the subject of "bearings" will not only form, when completed, the best collection of information upon this important machine element available, but it will doubtless lead future committees on meetings to endeavor to select similar stimulating topics for coming occasions.

In this connection it may not be amiss to consider the extent to which the material provided for discussion affects the success of any such gathering of professional and technical men. Some papers are very properly prepared and presented as matters of record, and include valuable data and results of researches which might otherwise remain unpublished and unavailable. Other contributions, fortunately growing fewer in number, and less obvious in nature, are intended to give publicity to the interests of individuals. But there are still other papers which should be most welcome as to contents and are of real value to the meetings at which they are presented, but which might be made still more valuable if they were prepared in a slightly different manner.

Papers for record may sometimes be presented by title, without involving any great loss to the members, absent or present, since their usefulness exists in their availability for reference. The great value of most papers, however, lies in their effect in interesting members to discuss the salient points, and thus to add, from record and memory the results of varied experience.

A paper should make those to whom it is addressed "sit up and take notice," and to do this it should be put into such form that its full purport is appreciated from the first, the salient features being brought out with due proportion, and the conclusions emphasized with full weight. As a successful playright once said with regard to the presentation of a telling incident to an audience "First you must tell them that it is coming, then impress them as powerfully as possible that it is occurring, and finally explain to them that it has happened." All scientific men are not playwrights, and perhaps this is just as well ; but in a great number of instances excellent technical papers have been presented and passed by without discussion, simply because the form was such that the full purport could not be generally grasped by such casual examination as most men feel able to give.

* * *

Now that the plans for the new building for the United Engineering Societies have been published and distributed to the membership of the three National societies, it may be of interest to note some of the salient features of the structure which, in about a year, is expected to be ready for occupancy. Probably no building of similar character has been the subject of so much careful study by those who are to occupy it, and to the original plans of the architects there has been added the benefit of the experience of a number of eminent men in various branches of the engineering profession.

The result is a building of most effective external appearance, containing a great auditorium especially designed for professional sessions, and yet affording in the immediate proximity ample facilities for social intercourse. With this are associated suites of modern business offices for purposes of administration, as well as a number of smaller halls for gatherings of various numbers, and these halls are all provided with equipment equal to that of a modern university. Above all are placed the quarters for what will doubtless become the greatest scientific library in the country, including rooms for private research and investigation, for indexing and collaboration, and for special library work. The book stack is ample for future growth, and the whole arrangement is that for a library intended for active service for men who know how to use it.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE GAS-TURBINE PROBLEM.

A CONSIDERATION OF THE PRACTICABILITY OF OPERATING TURBO-MACHINES BY THE DIRECT UTILISATION OF THE GASES OF CONTROLLED COMBUSTION.

Dugald Clerk—Junior Institution of Engineers.

WE have already reviewed in these pages the accounts which have been made public concerning the successful experiments in the operation of a gas turbine in Paris by Messrs. Armengaud and Lemale, while among the important contributions to this question we may be permitted to mention the papers of Dr. Lucke and Professor Reeve in the leading pages of recent issues of this magazine. The latest study of the subject of the gas turbine is found in the address of Mr. Dugald Clerk, upon assuming the office of President of the Junior Institution of Engineers, from which we make some abstracts.

"In most of the recent discussions upon gas-turbine problems, it has been recognized that the temperatures possible in the cylinder gas-engine are impossible for the gas-turbine. It has been fully proved by many investigators that the temperature quite common in ordinary gas-engine practice ranges as high as 2,000° C., though in the best practice, for most economical results, 1,500° C. or 1,600° C. appears to be an upper limit. With these temperatures, a first-class modern gas-engine of about 50 horse power will give an indicated efficiency of 35 per cent. At the same time, the negative work of the cycle is so low that the mechanical efficiency of the engine may be as high as 86 per cent., or even more. If one realizes what the temperature of 2,000° C. means, it becomes very evident that no turbine constructed either on the lines of Parsons or Laval could possibly be made to work with continuous supply of such gases; as 2,000° C. is considerably above the melting-point of platinum. It is much higher than the temperature at which cast-iron flows from the crucible, or, indeed, the temperature of the interior of the blast-furnace. Any blades of iron, steel, or, in fact, of any other material, even fire-brick itself, become fluid or semi-fluid at the temperature. It is obviously hopeless, therefore, to attempt in the gas-turbine temperatures which are quite feasible in the cylinder-engine. This fact is generally recognized. It is accordingly said, by those who take a favorable view of the gas-turbine, that it is necessary to supply the turbine with gases at a much lower temperature. Mr. Neilson fixes the temperature of 700° C. as one which steel turbine blades would probably stand without too rapid deterioration. I fear that on this point I must differ from him, because, in my experience, oxidation of steel (and even iron) is a fairly rapid process at this temperature. Nothing new has been proposed as to the thermo-dynamic cycle of the gas-turbine; so that all reasoning upon efficiencies depends upon the deductions already made from internal combustion engine practice.

"Seeing the impossibility of constructing a turbine with materials to stand a high temperature, many have proposed to convert high temperature into kinetic energy, so that instead of having work stored up in the gas in the form of heat, the heat shall disappear, and the energy of the heat be transformed into motion of the gaseous particles at a high velocity. Such proposals, then, include the compressing of a gaseous mixture to (say) 50 lbs. or 60 lbs. above atmosphere; the igniting of that mixture within a combustion chamber at constant pressure; and the expansion of the mixture through an expanding jet of the Laval type so as to drop the temperature and obtain its equivalent in kinetic energy or velocity of the gaseous particles. The rapidly moving particles at the relatively low pressure and temperature are then allowed to impinge upon rapidly rotating blades of sickle configuration; and they are supposed to give up their energy of motion on the blades, and so expend work upon the turbine."

The cycle of operations involved in a gas turbine of the kind considered by Mr. Clerk requires a rotary compressor of high relative efficiency to supply the air to the fuel and deliver the products of combustion to the nozzle. A nozzle is then necessary, of such design as to insure a free expansion which shall be quantitatively equivalent to adiabatic expansion behind a piston. The discharge from the nozzle must then be delivered upon a rotating turbine of such construction as will secure the transformation of the kinetic energy of the moving gases into effective work with a high degree of efficiency.

"Assuming air to be the working fluid, and the specific heat to be constant through the temperature range, it is easy to calculate the efficiency of the Joule or Brayton cycle, that these operations in effect represent. It would be useless to attempt to work a turbine at a pressure so low as to be relatively inefficient compared with the gas-engine, so I have chosen a Joule cycle of (say) 48 per cent. ideal efficiency, which in a cylinder gas-engine would probably give in practice about 30 per cent. indicated efficiency. For this ideal efficiency the pressure of compression would require to be 141 lbs. per square inch absolute. To give power with a reasonably small pump, I shall assume a maximum temperature of 1,700° C.—that is, assuming a perfect compressor and a perfect nozzle expander, the temperature would only fall from 1,700° C. to 750° C. Plainly, this temperature would be too high for a Laval disc with blades. In order to get a reasonable temperature on expansion, it would be necessary to assume a maximum temperature in the combustion chamber no higher than 1,000° C.; and this would bring down the temperature after complete expansion to about 500° C., which, no doubt, steel turbine blades can be expected to stand for some considerable time.

"With these assumptions, however, the gas-turbine would not be very economical as compared with cylinder engines, even assuming all difficulties overcome. The theoretical and practical difficulties, however, are very serious indeed. To begin with the question of an efficient air-compressor. I am not aware of any turbine compressor capable of compressing up to 140 pounds absolute from atmosphere with anything like 60 per cent. efficiency. Before success could be attained, this efficiency of compression (so far as diagram is concerned) should be at least 90 per cent. in order to allow for unavoidable mechanical and other losses in the subsequent processes. It has, it is true, been proposed to substitute cylinder compressors operated from the turbine, instead of turbine compressors; but this, it appears to me, would be equivalent to abandoning at once all the advantages of the turbine principle. If reciprocating cylinders are to be used for compressing, there is no objection to using them also for expanding."

Mr. Clerk has serious doubts as to the practicability of obtaining the temperature drop with an expanding nozzle in a manner to that existing behind a piston in a cylinder, and in this point he is largely sustained by the experiments of Dr. Lucke. Assuming, however, that adiabatic expansion can be secured by extreme care in design and construction, the problem of the conversion of the motion into work remains to be solved. Even the best steam turbines do not attain as high an efficiency as the best piston engines, it being found impossible to adjust the velocity of the blades to suit the varying velocity of the steam; and this difficulty becomes still more serious with the gas turbine. Assuming efficiencies of 90 per cent. each for the compressor and nozzle and 80 per cent. for the conversion in the turbine, Mr. Clerk computes that the best efficiency to be expected for the whole machine will not be above 22 per cent., somewhat lower than is now attained by well designed gas engines.

So far as the mechanical difficulties are concerned, Mr. Clerk admits that these may be minimised by the use of the so-called mixed turbine, in which steam and gas together are discharged upon the wheel, but he believes that this would result in a still further efficiency. It is this process which is advocated by Professor Reeve, and which has already been put into practice by Armengaud and Lemale, and it certainly appears to be more promising than the dry gas turbine. There is no doubt that questions of mechanical design and construction enter into the problem to almost as great an extent as those of thermodynamic theory, but it is not impossible that the constructive difficulties may be overcome.

The desirability of the successful solution of the gas turbine problem is not to be based altogether upon the single element of thermal efficiency, since such matters as convenience of application and smoothness of motion are also of much importance. The present internal-combustion motors, operating upon the Beau-de-Rochas cycle have the great disadvantage of furnishing only one power stroke in every four, this demanding heavy fly wheels and special regulators to insure a steady and smooth motion upon the shaft. The possession of a small, high-power, high-speed rotary combustion engine would be found a great advantage for motor cars, for aerial navigation, and for numerous uses which are now obliged to use the reciprocating four-cycle motors, and the mechanical advantages of the turbine might well be found to compensate for a slight loss in thermal efficiency. The gas-turbine problem offers many difficulties, but these have not yet been demonstrated to be impossible of solution, and the inducements are undoubtedly sufficient to cause many to continue their efforts to achieve success.

THE FIRE RISK IN THEATRE BUILDINGS.

AN ENGINEER'S OPINION CONCERNING THE DEFECTIVE CONDITION OF FIRE PROTECTION IN MODERN THEATRE BUILDINGS.

John R. Freeman—American Society of Mechanical Engineers.

IT is a custom, and a most admirable one, in the American Society of Mechanical Engineers, that the presidential address, instead of consisting of a mass of generalities upon the broad field of the work of the engineer, shall be based upon that department of engineering work with which the speaker himself has been closely identified. As a consequence, the transactions of the society are annually enriched by monographs upon important departments of engineering, forming records of ripe experience in practical fields in which success has been achieved. At the recent meeting the retiring president, Mr. John R. Freeman, spoke upon one branch of the subject in which he is a recognized authority, that of fire prevention and fire protection, calling attention to the great defects which exist in modern theatre buildings as regards fire risk, and suggesting the importance of giving proper engineering supervision to such structures.

Mr. Freeman compares the present status of fire protection in theatre buildings with that existing in manufacturing establishments, most unfavorably as regards the former class of structures, and we quote some of his remarks in this respect at length.

"It is a fair and moderate statement that fire protection as applied to theatres and buildings of public congregation is from ten to twenty years behind the fire protection of large industrial works, and true that the fire hazard to theatre property in general, as measured by insurance rates, is ten times as great for the modern theatre as for the modern factory. All of this is unnecessary. The safeguards needed are mostly simple; the main features of some of them are already worked out in the great factories, and the additional safeguards required to be worked out or adjusted for this special case are the automatic smoke vents, the safe proscenium curtain, the safe warming and ventilation and the proper arrangement of automatic sprinklers on stage and in dressing rooms and storerooms. In the factories of New

England chiefly there are the most advanced methods of fire prevention anywhere to be found.

"In the course of my own studies of the theatre and auditorium problem I have seen almost everywhere conditions affecting the safety of life that would not be tolerated for a moment by the managers of our best industrial works. For example, I have seen in one of the best New York theatres the wedge shaped space beneath the sloping floor of the auditorium used as a storeroom for trunks and properties. This room was also the plenum chamber for the ventilation. Suppose that any cause should start even a slow smouldering fire in this room; the smoke rising through the air ducts in the floor might throw the audience into a panic and cause great loss of life. In one of the most famous halls in America I found the portable wooden flooring used to transform the main seating space into a ballroom, stored in a dark passageway which formed the main air chamber between the heating coils and the concert hall, all thus kiln dried to perfection, and when I showed it to the manager and to an intelligent aldermanic committee and urged its immediate removal they saw no danger and thought me hypercritical and could not even see that automatic sprinklers would be of use in such a concealed storage space. In Chicago, within a few months after the appalling disaster at the Iroquois Theatre, the aldermen rescinded the rule calling for automatic sprinklers over the stages and rigging lofts of the theatres because the managers believed they wouldn't do any good and might start a panic should one happen to open prematurely. Every factory manager or mill engineer will admit the absurdity of such a statement. In Boston the law still accepts the non-automatic sprinkler pipe, to be opened by hand, a device which has now been generally discarded in factory fire protection, in favor of the automatic. Most important of all, I have found behind the scenes and in the mechanics' rooms a lack of the scrupulous neatness and order that characterizes a modern well organized factory, have found a multitude of dark, concealed spaces used as catch alls and an apparent lack of appreciation by owner and architect that a flood of daylight in storerooms, workrooms and dressings rooms is the best of safeguards by making dirt, disorder and dangerous rubbish conspicuous."

Mr. Freeman described the study which he had made of the fire at the Iroquois theatre, in Chicago, in which such a great loss of life occurred, referring also to the disastrous fire at the Ring theatre, in Vienna, the fire at the Brooklyn theatre, and others, and showed that the sequence of events was practically the same in all such disasters. In practically every instance the following events took place:

"A stage crowded with scenery.

"The sudden spread of the flames over this scenery.

"The opening of a door in the rear of the stage, an inrush of air.

"Scant smoke vents over the stage, an outburst of smoke under the proscenium arch.

"Death to those in the galleries.

"The obvious suggestion might be: Make the scenery incombustible; but the efficient fireproofing of scenery, so that it will not all burn up if a fire once gets well started on the stage, simply appears to be impracticable.

"The ordinary construction with a high, spacious chamber for the hanging loft above the level of the proscenium arch makes it a simple matter structurally to keep this fire and smoke out of the auditorium, and no matter how great the mass of flaming scenery a smoke vent of one-eighth or one-tenth the area of the stage, if instantly opened, would probably prevent suffocation. The conditions are similar to those of a fireplace. The high space over the stage screened by the arch is adapted to give the best of chimney draft. An ordinary rule is to make the throat of the chimney at least one-tenth the area of the fireplace opening, or the space through the damper one-eighth the area of the hearth, and when we simply provide an adequate chimney area and a damper that will surely open we shall have adopted a safeguard that would have saved four-fifths of those who perished at the Iroquois, regardless of defective curtain, defective exits and absence of fire hose on the stage."

The first precaution for the control of fires in theatres is the provision of a sufficient opening or vent for the smoke and flame above the stage. Mr. Freeman showed that the requirements of city ordinances in this respect are generally evaded, partly because of the desire to prevent draughts of cold air upon the stage, and to avoid inconveniences from leaks in rainy weather. Mr. Freeman described several designs of ventilators which would obviate these inconveniences, and at the same time provide a full and effective opening in time of fire, these including movable shutters which are opened automatically by the parting of fusible links. The fundamental requirements of such events are as follows:

"Absolute certainty of opening by force of gravity, in spite of neglect, rust, dirt, frost, snow or expansion by heat, twisting or warping of the framework, quickness of opening to be secured by automatic links of the thinnest metal practicable and also by controlling the doors by a cord run down to the prompter's stand and to the station of the stage fire-guard; the operative mechanism of the smoke vent should be simple and massive; it should be of such form that it can be tested daily or at least at the weekly inspection by partially opening it, preferably closing it again by means of the cord running to the prompter's stand. It may add to its safety if it can be used whenever needed for the ordinary ventilation of the stage, thereby keeping it under constant notice."

After the proper venting of the stage, the second safeguard to be provided, in the opinion of Mr. Freeman, is the complete equipment of the stage and other parts of the building with automatic sprinklers, the auditorium alone being excepted. There appears to be no reason for believing that such sprinklers as have proved themselves effective in mill buildings would not also act in a satisfactory manner in theatres, and open with sufficient promptness to be of material service.

The third safeguard is the curtain which closes the opening of the proscenium arch. In nearly all theatres this protection is attempted to be furnished by the use of a curtain consisting of a heavy canvas woven of asbestos fibre. There are several materials answering to the name of asbestos, and care should be taken to ascertain that the fibre used contains no chemically combined water, since this is readily given off under the application of heat, rendering the material liable to crumble and break to pieces. Experiments made by Mr. Freeman have shown that ordinary asbestos curtains give but little protection, being difficult to guide, and liable to be forced out into the auditorium by the pressure of the expanding air and gases behind. The steel curtains required in Chicago are better, but these are rarely provided with proper guides, and unless fitted with metal guides capable of holding them firmly, while permitting smooth and rapid lowering, they are not effective, but when properly fitted they should be serviceable.

"In safeguarding our factories against fire, we find systematic inspections and the filing of a weekly report one of the very best means toward safety. They would be of equal value for the theatre. A printed blank can readily be devised for each case. This should cover the completeness and operative condition of all valves, fire hose, sprinklers, fire pails, soda water extinguishers, hooks, fire doors, exit locks and latches, smoke vents, fire curtain mechanism, and particularly of the neatness, cleanliness and order of every room, passageway, closet, air chamber, loft, basement and fly gallery, used as a part of the theatre building. This inspection should be made on each Monday afternoon, since the week end is the time when attractions are commonly changed.

"A private fire brigade from the regular stage hands and ushers should be drilled regularly, the Monday drill to be a wet drill testing the stage hose and a few of the soda water extinguishers, which may be turned out of the window to the areaway or into some convenient drain provided for the purpose at the rear of the stage. The head stage carpenter should always be present during a performance as chief of this brigade.

"If the municipal ordinance required such reports and drills as just described and that a duplicate of the report be filed each Monday afternoon with the public fire chief of the district, a single fireman or inspector detailed as instructor to cover all the theatres of a large city would, in my judgment, accomplish more real good than the two stage firemen required by law to be present from the public force.

RAILWAY MOTOR CARS.

APPLICATIONS OF STEAM AND INTERNAL-COMBUSTION MOTORS TO THE PROPULSION OF INDEPENDENT VEHICLES ON RAILWAYS.

A. Heller—Verein Deutscher Ingenieure.

THE success which has attended the development of the automobile vehicle for use of streets and highways has naturally led to the design of self-propelled cars for special service on railways, and for many purposes where it is not desirable to employ a locomotive and train such independent vehicles have come into use.

In a paper recently presented before the *Verein Deutscher Ingenieure* by Herr A. Heller, and published in the *Zeitschrift* of the society, there is given an extended review of the motor cars now in use on the Continent and in Great Britain, these including both steam propelled cars and those using internal-combustion motors similar to the engines of the heavier automobiles, employing benzine or gasoline as fuel.

Independent motor vehicles are generally used for local service on short feeder lines, but in some cases they are used either alone or to haul short trains of trailer cars on main lines. An example in point is cited in the case of the Great Western Railway at Swindon, where independent motor cars on the main line have been used to compete with a trackless electric omnibus service which paralleled the railway for about seven miles. Other applications have been found for such vehicles to fill in the service between the stops of express trains, for the replacement of special trains, and for many occasions for short local services for which the cost of regular trains would be found excessive.

The independent motor car is essentially intended to be a separate vehicle, and its use to haul trailers is limited to a few light cars to meet extra demands for transport or for the hauling of baggage or small quantities of merchandise. Practically all the cars described by Mr. Heller consist of a combination design, the propelling machinery being arranged at one end or beneath, the rest of the vehicle containing seats for passengers, some of these cars seating 50 passengers.

A large number of the vehicles now in use on steam railways are propelled by steam motors, a favorite type having horizontal cylinders beneath, and a vertical steam boiler at one side of the motorman's compartment in front. Some of these machines have high-pressure cylinders only, while others are arranged with cylinders of unequal diameter, permitting compounding upon the system employed in the United States for such service by Baxter as long ago as 1875, and in France by Mallet about the same time. Water-tube boilers of various types have been introduced for this service, the machine built for the Northern Railway of France, having the well-known Turgan boiler, while the vehicles constructed by Ganz & Co., of Budapest, have a vertical shell boiler with an inner shell and short water-tubes between the two shells. For large powers, i. e., for motors of about 100 horse power, two such boilers are used, this permitting a convenient arrangement, and allowing of alternating firing. In some cases, as in the steam motor cars of Komarek, of Vienna, superheating is employed, the Komarek boiler being of the coil water-tube type, with separate steam drum.

The application of internal-combustion motors to railway motor cars naturally follows from the successful results which have been attained with such motors in automobiles. Thus the Daimler company have made several sizes of motor vehicles, operated by motors similar to those designed for road automobiles, while on the North-Eastern Railway a mixed design has been used, this consisting of an internal-combustion motor driving a dynamo, supplying electric motors by which the car is propelled, a storage battery supplying current when the motor is not running.

The reduction in resistance offered by tracks over the rough surface of common roads renders it practicable to obtain a much higher tractive efficiency than is possible upon ordinary highways, and hence the motors which are supplied to automobiles carrying but a few riders are amply powerful to transport a large number of passengers in cars running on railways. Motors of 10 to 30 horse power are found sufficient to propel cars at speeds ranging from 30 to 60 kilometres per hour, carrying 30 to 50 passengers.

As an example of the economy of such cars for local passenger service, Herr Heller shows that for the transport of 150 passengers under ordinary conditions there would be required a locomotive, weighing at least 25 tons, and three passenger carriages of 15 tons weight each, or a total of about 70 tons. The same number of people could readily be transported with one motor car and two trailers having a total weight of less than 45 tons, with a corresponding reduction in fuel and wear.

The advantages of motor railway cars must be apparent to railroad men when the opportunities which they offer for reductions in operating costs are considered. It is not claimed that they are directly economical in fuel consumption, but the proportion of dead to paying load is far lower than can be attained for ordinary local trains, while the facility of operation and the low cost for operating crews combine to minimize the total expense. When run in connection with branch feeder lines they may be made most useful in the gathering of local traffic at main stations, thus enabling steam roads to meet the serious competition of electric and interurban lines. For inspection purposes and for the occasional demand for special transportation the motor car offers obvious advantages over the trains now used for such service, and there is every reason to believe that such machines will come into extensive use, even on the great trunk lines.

SPEED TRIALS OF NAVAL VESSELS.

METHODS USED IN ACTUAL PRACTICE FOR MEASURING THE TRIAL SPEEDS OF VESSELS FOR THE AMERICAN NAVY.

J. J. Woodward, U. S. N.—Society of Naval Architects and Marine Engineers.

AMONG the papers presented at the recent convention of the Society of Naval Architects and Marine Engineers we note one by Naval Constructor J. J. Woodward upon the important subject of the methods of conducting speed trials in the United States Navy. As Mr. Woodward remarks, this is one of those important problems for which we have only approximate and not exact solutions.

After reviewing the historical side of the subject, and showing the unreliability of the old-fashioned chip log and of the so-called patent log, Mr. Woodward proceeds to compare the contract trial requirements in the navies of the United States and Great Britain, and calls attention to the tendency in both countries to demand endurance and economy trials as well as the determination of speed.

Referring more especially to the methods employed in the United States, Mr. Woodward describes at length the manner in which the trial course at Cape Ann is laid out and marked, this being so arranged as to permit runs of 33 or 44 nautical miles, the positions of the buoys being determined by ranges and angles from points on shore. The depth of water along the course has been determined by careful soundings, it being generally 40 fathoms or more, there being two lumps of about 25 fathoms and one between 30 and 40 fathoms.

Referring to the observations made to determine the influence of currents upon speeds, Mr. Woodward gives these as they are now conducted, but does not hesitate to express the opinion of himself and other officers that these can be nothing more than approximations with little real value. The detailed operations involved in the conduct of a speed trial and the method of combining the observations are given at length, but for these the reader must be referred to the original papers. The treatment given is that of the French Naval Constructors Pollard and Dudebout. From the data obtained during the trial a speed curve can be constructed, and from this curve a number of important relations concerning the vessel may be deduced. Of these relations two of the most important may be considered, these being the exact determination of the true speed through the water and the corresponding number of revolutions of the engines when the vessel is run at her highest speed over the mile course; and, the accurate determination of the direction of the speed horsepower curve where it passes through the point of maximum speed.

"In considering the first of these requirements, especial weight should be given to the fact that, even with a properly established trial course, our observations are subjected to accidental errors owing to irregular fluctuations in the current and to variations in the personal equations of the observers, so that a considerable number of observations are essential if reliance is to be placed on the result. The minimum number of runs that would appear to be satisfactory for this purpose is five. The French Admiralty method of combining the results of this number of runs is especially desirable since it permits an immediate appreciation during the trial of the regularity with which the current is varying. This follows from the fact if the speeds resulting from the averages of these two sub-groups differ to any noticeable extent, it may be immediately observed and the number of runs at this highest speed may be increased until a sufficient number are obtained to insure that irregularities in the results due to errors in one or more of the observations shall not materially affect the final value determined for this highest speed.

"The determination of the direction of the curve at its upper extremity theoretically requires only a knowledge of the position of one other point in the curve, which should be located sufficiently near the point of highest speed to permit a line joining the two points to represent the tangent to the curve at its highest points. With this information, the speed on a four-hour trial could be accurately determined whenever this speed only differed from the highest speed observed in the standardization trial, by a small fraction of a knot. The accuracy of this method of the determination of the speed on a four hours' trial, would however, rapidly decrease as the difference between the speeds increased; and such a method would moreover afford the minimum general information as to the efficiency of the ship and its machinery, for a given number of runs over the measured mile. This is evident, since to construct the tangent we must know the position of the second spot on the curve with the same accuracy as the first, which would require five additional runs at a speed only slightly lower than the highest speed obtained on the mile course. Ten runs would, therefore, have been made, all at powers requiring forced draught to the maximum, or nearly maximum permissible amount, and the net result would be the determination of two neighboring points on the speed power curve.

"If instead of limiting the investigation of the speeds developed on the measured mile, so that it will furnish only the minimum amount of information required to determine the speed during a four-hour full power trial, a larger number of points of the speed power curve are established through such a range of speeds that a considerable part of the upper portion of this curve is determined, it will be found that although the number of runs over the mile course is increased, the difficulty of conducting a successful trial is diminished, since the number of runs at the higher speeds may be materially reduced. The propriety of this reduction will be plainly seen if it is remembered that since it is now proposed to determine a number of points on this curve, the runs made at other than the very highest speed can be made in a series of gradually reduced speeds, for which the corresponding horse powers fall even more rapidly. The desirability of making a number of runs at considerably less than full power is the more evident if it is further remembered that since we are now determining the direction of the curve at its upper extremity by establishing the position of a number of its points, it is obvious that if we restrict the observations made to the immediate neighborhood of the upper extremity of the curve, irregularities in the observations of any given amounts will affect the resulting determination of points further removed from the curve's upper extremity."

The trials of vessels are made primarily to demonstrate that the purchaser, that is, the government, has obtained what it is paying for, but apart from this the information obtained as to the relations between power and speed should be most useful in the future handling of the vessel. If the relations between the revolutions of the propeller and the speed of the vessel have been accurately determined the officers of the vessel will be supplied with data of great value for the determination of the speed at any time, experience having shown that the propeller is by far the best log which can be supplied, if only it has been accurately calibrated upon an accurately measured course. However opinions may differ as to the advisability of making the payments for a vessel conditional upon the results of her speed trials, there is no question as to the usefulness of such trials in determining data for the subsequent operation of the ship.

"In view of the present state of the art of construction of vessels for military purposes, it is essential to insure efficiency that the contracts for such vessels should provide, not only for a full power trial of a few hours' duration, but also for additional trials each lasting at least 30 hours in order to determine:

"The endurance of the propelling machinery at the highest power that can be continuously maintained at sea;

"The economy of coal consumption at a cruising speed—approximately that corresponding to the maximum cruising radius of the vessel.

"It is believed to be imperative, in order to properly care for the matériel of the vessel, that such trials should be conducted by a naval crew, the builder to have, however, as many men on board as he may desire and to retain full control and responsibility for the operation of the machinery which he has built. Such a procedure would follow the practice of all other first-class naval powers.

FUEL GAS PRODUCTION.

A REVIEW OF THE PRODUCER GAS TESTS OF THE UNITED STATES GEOLOGICAL SURVEY COAL TESTING PLANT AT ST. LOUIS.

R. H. Fernald—American Society of Mechanical Engineers.

IN previous issues of this Magazine the general equipment of the coal testing plant at the St. Louis exposition has been fully described, and a summary of the methods of work and the results given in papers written by Mr. Parker. Since that time the work of the Geological Survey has been continued, and an additional appropriation made by Congress has enabled this important department of technical investigation to be extended.

In a valuable paper presented at the recent convention of the American Society of Mechanical Engineers by Professor R. H. Fernald, himself actively connected with this important piece of research work, an account is given of the results which have been obtained with fuels of various grades when consumed in the gas producer.

Professor Fernald called especial attention to the fact that the tests were tests of fuels and not of producers. All the tests were made in the same producer, one originally designed for use with anthracite coal, and this apparatus was necessarily not equally well adapted for bituminous coal, for lignites, and for anthracite. Under the conditions governing the tests it was impracticable to adapt the producer especially to the fuel, but on the whole the results were faily satisfactory. Each fuel was tested, both in the producer and under a boiler, the gas from the producer being used to operate a Westinghouse gas engine, while the steam from the boiler drove a Corliss engine, the power in each case being converted into electrical energy and thus measured. In this way there were obtained results showing the advantages obtained by the use of the producer over the boiler. The tabulated results of these comparative tests show that in nineteen different trials the quantity of dry fuel required for the development of one electrical horse power was more than twice as much for the steam plant as for the gas plant. In fact, the ratio of the coal consumed per horse power by the gas plant to that required for the steam plant is given as 2.57 or more than two and one-half times in favor of the gas plant.

It may be argued that such a marked difference would not appear if a triple-expansion condensing engine were used in the steam tests, instead of a simple non-condensing Corliss engine. Mr. Fernald calls attention to the fact, however, that the gas engine employed was by no means of the most modern design nor economical type, and maintains that if the most modern steam plant were compared with a correspondingly modern and well adjusted gas plant, the ratio of fuel consumption would be about the same as that shown in the present tests.

The calorific value of the gas depended somewhat upon the nature of the fuel, ranging from about 140 British thermal units per cubic foot of gas to 188 thermal units. This latter result was obtained with a lignite from North Dakota, a fuel containing so much moisture as to be considered altogether unsuited for use under steam boilers, but evidently well adapted for the gas producer. The presence of the moisture resulted in the production of a partial water-gas, the gas from this fuel showing upon analysis more than 14 per cent. of hydrogen.

The demonstration which these trials have made as to the adaptability of so-called low-grade fuels to the production of fuel-gas for gas engines is one of the most noteworthy results which have followed the conduct of the researches upon the coal testing plant of the Geological Survey. The expenditure of a few thousand dollars in these tests will doubtless result in the utilization of beds of fuel hitherto neglected as being commercially worthless, while the impetus which the investigations will give to the industry of building producers and gas engines cannot but be very marked.

So far as the actual performance of the gas plant is concerned, the results have demonstrated very fully the efficiency of the gas producer and gas engine as a means of obtaining energy from coal. The official records show that performances as low as 0.95 pound of dry coal burned in the producer per electrical horse power at the switchboard have been obtained. This includes the efficiency of the dynamo and its belt transmission, and taking the efficiency of this portion at 85 per cent. we get a consumption of 0.8 pound of coal per horse power.

The determination of the amount of coal actually burned in the producer for any given period is, at best, a factor of more or less uncertainty. To reduce this possible error to a minimum it was deemed necessary to make the test on each coal as long as consistent. A schedule was therefore adopted at the beginning of this series of tests, involving two sixty-hour runs per week. The first eight to twelve hours of each test period are used for getting the fuel-bed into a uniform and efficient condition. During these preliminary hours records are taken as in the regular tests, but the official test, as reported, included only the last forty-eight or fifty hours of the run, during which time the conditions are maintained as uniform as possible.

To carry out this schedule it became necessary to add a second producer to the plant, so that the plant now consists of two independent producers both discharging into the same scrubber. These producers are worked independently, one being charged while the other is in operation. By this arrangement no time is lost in changing from one coal to another at the end of any test, as a simple manipulation of valves brings the second producer into operation when the first is cut out.

Owing to the lack of reliability in the operation of the gas engine, many of the tests conducted during the Exposition period were of a few hours' duration only, but since the present series of tests began (May, 1905) no difficulty has been experienced in starting the engine at 8 A. M. Monday and continuing day and night without a stop until 8 A. M. Saturday. During this period two different coals are tested and the change of gases is made at 8 A. M. Wednesday without stopping the engine.

An effort to do away with unnecessary appliances has furnished valuable and interesting information and has centered attention on several radical changes in the details of producer-gas plant construction.

It developed at an early date that more or less sulphur was passing the purifier and entering the engine cylinders. Investigations by the chemists showed that purifiers consisting of oxidized iron-filings and shavings were fairly efficient for coals containing little sulphur—one per cent. or less; but it was found that for coals containing larger percentages of sulphur the purifier was exhausted after about six or eight hours. Mixtures of lime and shavings were tried, but with little success. As a result of these investigations the purifier has been discarded and the gas, carrying its full percentage of sulphur, has been charged directly into the engine cylinders. This method of operating has been going on for many months and no ill effects have been discovered although coal has been used which runs as high as 8.1 per cent. sulphur.

One feature of the plant as installed was the economizer, used for preheating the air for the blast. A series of experiments has shown no effect upon the chemical composition of the gas or upon the efficiency of the plant when air at ordinary atmospheric temperature was substituted for preheated air. As a result the economizer, as an economizer, has been discarded, and the construction of the plant again simplified.

Other modifications and changes are under investigation at the present time, the most important from an economic standpoint relating to the utilization of slack coal in producers.

CONDENSERS FOR STEAM TURBINES.

METHODS FOR THE PRODUCTION OF THE MOST ECONOMICAL VACUUM FOR STEAM ENGINES AND TURBINES.

Frank Foster—Owens College Engineering Society.

IN the early history of the steam engine the separate condenser was an object of great interest, and in spite of the efforts of such pioneers as Trevithick and Oliver Evans the older engineers relied upon the vacuum on the exhaust side of the piston for the greater portion of the power produced by the engine. Later the high pressure engine assumed its position, and in many cases where water supply was limited, and fuel cheap, the condenser was omitted, while the development of the locomotive engine showed the possibilities of the engine which exhausted its steam against atmospheric pressure. Since the introduction of the steam turbine the importance of the maintenance of a good vacuum has been generally appreciated and numerous discussions have been made to show the superior performance of the turbine against a low back pressure.

In a paper recently presented by Mr. Frank Foster before the Engineering Society of Owens College the whole subject of modern condensers is reviewed at length, together with the important question as to the most economical vacuum, considered from the total efficiency of the plant.

The various types of condensers may be included in the following classification: Surface condensers; Barometric jet condensers; Non-barometric jet condensers; Ejector condensers; Evaporative surface condensers. These are described in detail by Mr. Foster, and the advantages of the barometric types shown, so far as vacuum and space required are concerned.

"The choice of a condenser depends a good deal on the working conditions. Where there is a plentiful and cheap supply of good condensing water suitable for boiler feed, a barometric injection condenser will generally be found most reliable, and generally suitable, especially so if floor space is expensive.

"Where the condensing water is not suitable for boiler feed, and where on the other hand it is not so dirty as to seriously impair the efficiency of a surface condenser by coating the tubes with sediment, then a surface condenser is as a rule preferable. The use of surface condensers on sea-going ships will illustrate the above case.

"Where the condensing water is difficult to obtain in large quantities, a barometric condenser is preferable to a surface condenser in most cases, as it uses less water —from 15 to 60 per cent. less, according to the vacuum and water temperature—and this also reduces the size of the cooling tower which must often be used. If, however, the condensing water is also of poor quality, so that it is not suitable for boiler feed, it may be desirable to use a surface condenser, especially if the vacuum is not very high.

"There is little doubt, the writer believes, but that the merits of the barometric condenser will come to be more widely recognised, and that in both turbine and reciprocating work they will largely replace surface condensers for land installations. For use with horizontal turbines the height of the barometric head above the turbine floor is a small drawback in many cases."

In considering the subject of surface condensers, Mr. Foster considers the question of the velocity of flow of the condensing water, giving the formula of Stanton for various temperatures of inlet and discharge water. There is no doubt that the vacuum is improved by giving the water a high velocity, but this is attainable only by an increased load upon the circulating pump, so that the gain on the one hand must have the increased resistance on the other offset against it.

"It appears from Stanton's formulæ and is confirmed by his experiments on actual condensers—that the outlet temperature is very little affected by the velocity of water in the tubes (the inlet temperature, the length of the tube, and the tube temperature remaining unaltered), falling off, however, a little as the velocity increases. Neglecting this small variation for the sake of simplicity, we see that as the total water passing through a tube is proportional to the velocity, the quantity of heat abstracted from the steam will be proportional to the velocity, and hence the number of tubes and the tube surface will be inversely proportional to the velocity of the water.

"Clearly, then, the cost of the condenser can be reduced by using water flowing at a high velocity. A high water velocity will send up the power required for the circulating pump roughly as the velocity, and this will tend to increase the cost of the condensing plant as a whole, as well as the cost of running the plant, so that there is evidently a limit to the velocity which is economically desirable.

"So long as the time factor—the proportion of the year during which the plant is running—does not exceed 12 per cent. the higher velocity is more economical than the lower. The *higher* the cost of fuel the *lower* this time factor. Within limits, the higher the velocity the greater the gain for time factors lower than 12 per cent.

"Clearly, then, as a general principle we may say that high water velocities are not desirable for plants which run fairly continuously, as in the case of marine and factory installations."

The question of the cost of cooling water is also considered by Mr. Foster. The extreme variations in this cost in various localities renders it impossible to give anything but a general consideration, but some fundamental principles may be examined. In general the extra expense of cooling ponds and towers is offset by the gain in fuel economy in proportion to the load factor and to the price of fuel. It follows that such things may be found desirable for a factory plant and at the same time unprofitable for an electric lighting plant.

Without attempting to examine into the reasons for the increased efficiency of steam turbines at high vacuum, Mr. Foster gives data and results from tests showing that there is a reduction in steam consumption of about 0.56 pounds per inch of vacuum per kilowatt per hour. If this were all we could not get too good a vacuum, but a comparison of the costs of condensing equipments shows that a 28.5 inch plant costs more than twice as much as a 26-inch plant, so that interest and depreciation charges must be taken into account.

"Now the most economical vacuum will be that at which the rate of increase in the fixed charges is just equal to the rate of decrease in the fuel cost, and not when the fixed charges themselves are equal to the reduction (total) in the cost of fuel; for when this former balance has been reached, then any *further* small increase in the vacuum costs more than the reduction in fuel cost it produces, yet the total reduction in fuel cost will be more than the total fixed charges. This point is very important, so we will illustrate it by an analogy.

"Suppose a business firm to try to increase their business by opening branches. Then they will cease to add to the number of branches when these new branches cease to pay for themselves, and not when the losses on these new branches just balance the profits on the older ones, and thus make the profit over the whole system of branches nothing."

By comparing a number of installations Mr. Foster shows the influence which the load factor of a station has upon this subject, and it is evident that a plant in which the load factor is low should not have condensers at all. The load factor of electric lighting stations is almost invariably low, the average factor of eight British stations ranging from 13 to 16 per cent.

"It would seem at first glance, therefore, that, except where coal is expensive, all these plants ought to be run non-condensing. A little thought will show us, however, that there is another course open to us which offers many advantages, and that is to provide condensing equipment for some engines—or turbines—only.

"Of course each installation must be considered separately and due weight given to the particular conditions of such things as cost of coal, water, and land, and the quality of the condensing water. Still it may be stated as well within the mark that in the majority of electric power stations only a portion of the engine plant ought to be equipped with condensers. The engine equipments of a factory have very different load factors, depending largely on the nature of the work done in the factory. In textile factories this load factor is often 25 per cent. and sometimes as high as 30 per cent., so that in general we may say that the engine ought to have a condenser. In large belt or rope driven engineering workshops the load factor is generally fairly high, and in works where there is a considerable night shift the load factor on one of the engines—if there are two or more—may be as high as 50 per cent.

"Where the factory load varies according to the time of the day and year, as is particularly the case with electrically-driven and lighted shops, it is advisable to have two engines, one of which takes the light loads and assists in taking the peaks. Unless a night shift is run—which would usually be supplied with light and power from this small engine—this small engine should, generally speaking, not have a separate condenser."

EXPERIMENTAL TESTS OF SAFETY LAMPS.

PRACTICAL TRIALS OF MODERN MINING LAMPS AT THE OFFICIAL TESTING STATION IN BELGIUM.

H. Schmerber—Le Génie Civil.

EVER since the introduction of the safety lamp following the inventions of Davy and of Stephenson, there have been attempts made to improve and modify the apparatus for providing safe illumination for the miners who are obliged to work in localities producing explosive gases. In many countries the control and regulation of such lighting appliances has been assumed by the government, as being a matter within the jurisdiction of the State, and this has been especially the case in Belgium, where the coal mines are notably liable to emit volumes of explosive gases. In a recent issue of *Le Génie Civil* there is given an account of the operation of the official testing station at Frameries, from which we make some abstract, as being of value and interest to coal mining industries in other countries.

There appears to be little doubt that the mines in the bituminous coal district of Belgium are among the most gaseous in the world. According to Stassart, there are some mines in the district which have emitted 30,000 to 40,000 cubic metres of explosion gases daily for years, and in some minds it has been estimated that as much as 250 cubic metres of gas are disengaged for every ton of coal raised. Under such conditions it is evident that the subject of explosions becomes a most serious one, and the work of the *Service des Accidents Miniers et du Grisou,* as the department is termed, under the skilful charge of the chief engineer, M. Watteyne, is an important feature of industrial administration. The work of the department is divided into two parts, one relating to safety in illumination, and the other to the safe use of mining explosives, and it is of the former portion of the service that M. Schmerber treats in the article under consideration.

The Belgian government has established at Frameries a very complete equipment for enabling practical tests to be made of lamps and other appliances, the equipment including a laboratory machine shop, gas holders, purifiers, and all necessary apparatus.

The gas used in testing the lamps is drawn from two seams about 700 metres below the surface, at a point where a fault has formed a sort of chamber not directly traversed by the workings of the mine, and it has been shown that at this point about 400 cubic metres of gas are disengaged daily. The gas is drawn through a pipe of 5 centimetres bore with walls 3 millimetres in thickness, the total length of the system being about 1,000 metres. Since the tightness of the pipe is an important matter it is so arranged that the lower end may be closed at any time, and the whole length tested by compressed air, this enabling any leak to be detected. It is also possible to draw off samples of gas from the lower end of the pipe and compare the composition with that delivered at the top, to see if any change has occurred during the passage.

The chamber in which the lamps are tested is so arranged that the lamp may be exposed, either wholly or in part, and in any position, to currents of the gas, at various velocities. The gas may also be charged with coal dust if so desired, and arrangements are also provided for testing the efficiency of relighting devices. Space is not available here for a detailed account of the apparatus and methods, but some of the more important conclusions may be given.

Three important questions have been thoroughly investigated at the Belgian testing station in connection with the use of safety mining lamps. The first of these is the possibility of permitting the use of mineral oils, instead of the vegetable oils hitherto prescribed. The second question, most important, is the practicability of relighting extinguished lamps within the mine; while the third point included the admission of a variety of lamps, rather than the enforcement of the rule compelling the use of a single prescribed type.

So far as the nature of the oil is concerned, it was formerly believed that mineral oils permitted the formation of explosive vapors, at least to a greater degree than was possible with vegetable oils. This question was definitely settled by the tests, it being conclusively shown that there was no greater danger with one type than with the other, while at the same type the lamps fed with essence, or with light mineral oils gave much better light and also afforded much better opportunity for the introduction of automatic relighting devices.

This question of relighting is a most important one. With all precautions in construction and care in use the lamps in service are apt to go out. Under the old regulations the miner was obliged to return with his lamp either to the surface, or to a lighting station, usually placed away from the workings and near the base of a ventilating shaft. This meant loss of time, and a tedious trip without a light, and has led in many cases to attempts by the miners to open the lamps, by false keys or otherwise, to permit relighting on the spot. Many explosions have been attributed to attempts at relighting lamps in explosive atmospheres, and a remedy for the practice is most desirable.

The lighting devices which have been tested consist of some sort of band or tape composed of paper or paraffined tissue, and containing at intervals small primers of phosphorus or other composition, ignitible by percussion or friction. If the lamp goes out this strip can be operated from without, the lamp remaining closed, and a fresh light thus obtained. The experiments showed that such devices are not always safe, since with some forms of lamps the flame produced by the relighting primer is found to traverse the gauze of the lamp and ignite the gas without.

Comparative tests of a number of lamps have shown that some of the later models are superior to the form previously given sole authorization for the Belgian mines, and it is probable that requirements of conformity to the tests of the department will be made the condition for use hereafter.

A number of careful tests of standard lamps have been made to show their behavior in the presence of coal dust, but the results have been wholly favorable, showing that the risks on this account are negligible. Other points of interest in connection with the tests relate to the material of the wire gauze. Although gauze of brass or copper wire has the advantage over iron as regards freedom from rust, the brass gauze is liable to fuse if overheated, and this defect exists in a lesser degree with copper gauze. Formerly the glass portion of the lamp, about the flame, was made thick, in order to minimize danger of breakage. With the later lamps the heating is more rapid, and it is found that thinner glass is less liable to break from unequal expansion than the heavier material, especially when drops of water strike the exterior of the lamp.

It is evident that the systematic investigations of the real elements of safety and service of lamps in the Belgian mines have produced valuable results, and the experience thus gained may well be applied elsewhere.

THE ELECTRICAL TRANSMISSION OF INTELLIGENCE.

PROBLEMS OF ELECTRICAL ENGINEERING INVOLVED IN THE MAINTENANCE OF COMMUNICATION BY TELEGRAPH AND TELEPHONE.

John Gavey—Institution of Electrical Engineers.

ELECTRICAL engineering is generally assumed to be that department of the profession dealing with such questions as to operation of great generating stations, the transmission of heavy currents at high pressures for the development of mechanical energy, propelling tram cars, driving machinery, and other conspicuous and obvious applications, or for the production of numerous and brilliant lights.

It must not be forgotten, however, that most important results are produced, both technically and commercially by the applications of such weak currents as are employed for the transmission of intelligence by means of the telegraph and telephone. This department of electrical engineering formed the principal subject of the presidential address of Mr. John Gavey, recently delivered before the Institution of Electrical Engineers, the subject having especial appropriateness from the fact that the Institution itself is the outgrowth of a previous society of telegraph engineers.

After referring to the wide use of telegraphic appliances for special purposes, such as the regulation and control of railway signals, fire alarms, and the like, Mr. Gavey takes up the subject of ordinary telegraphs, giving some statistics to show the great development which has taken place between 1879 and 1904, both in Great Britain and in the United States.

Referring to the possibilities of future growth, Mr. Gavey points out that much depends upon the action of local authorities, since the insistence of methods which involve costs beyond the commercial possibilities of the business simply act to stifle the industry.

"If we now consider the actual apparatus by means of which commercial telegraphy is effected, perhaps the most surprising fact that strikes the observer is the predominance of the use of the ordinary Morse code and Morse apparatus throughout the world. At first it seems surprising that, notwithstanding the innumerable inventions of printing, writing, and drawing telegraphs, the original system—of course, much improved—still holds the field generally, notwithstanding the partial use of the Hughes and Baudot printing systems on the Continent of Europe. On consideration, however, it will no doubt be seen that, in comparing the Morse with other systems that at first would appear to be superior, its simplicity, its relative freedom from trouble, electrical or mechanical, the ease with which its alphabet is learned, and a skilled telegraphist is trained, and its adaptability to high-speed or multiplex working, all help to maintain it in the forefront, and undoubtedly qualities will for a long time prevent or delay its general replacement by other types of instrument where the speed of working that is necessary is not greater than can be achieved by an operator manipulating a key. Where high-speed automatic Morse apparatus, however, is in use, the want of a means of automatic transcription which would save the labour and delay of manual transcription has long been felt, and extremely promising systems have been devised whereby the problem has been solved in two different ways. In one which was recently illustrated in a paper read before the Institution a perforated slip is used for transmission, as in the ordinary Wheatstone system, but instead of the signals being received in Morse characters at the far end, a second slip is perforated, the exact counterpart of the original; this is placed in an automatic typewriter, which prints the message on ordinary typo. Two different methods of applying this system are now under the consideration of the Post Office. In others the transmission is effected by means of a perforated tape, the message, however, being printed by the receiving instrument, either by a direct impression from a type-wheel, or in one case by a photographic reproduction of each letter as the type-wheel revolves."

The subject of space telegraphy is discussed by Mr. Gavey, reviewing the development from the early experiments by the induction through the progress which has been made in the application of the phenomena of Hertzian waves, through the work of Branly, Lodge, Marconi and their associates and followers.

"A great deal has been said by rival inventors as to the possibilities of wireless telegraphy, and some exaggerated claims have been made on their behalf which have led to counter statements by some interested in other methods of communication. Whilst, on the one hand, it may be fairly assumed that wireless telegraphy is not, under any circumstances, likely to supplant, or even to compete seriously with, inland methods of intercommunication, there is no doubt that there is a very distinct and important sphere of utility awaiting its further development. For intercommunication between ship and shore, and ship and ship, much has been done, although much remains to be done. For intercommunication between neighbouring coasts there is also a possible future, but this depends almost wholly on the further development of the methods of syntony or tuning. There appears to be doubt that in cases in which the wave-lengths used on two systems differ to a considerable extent, a very marked degree of success has been obtained in the avoidance of mutual interference. Where the wave-lengths, however, are not very widely apart in frequency, there is in each case a definite range within which interference arises, and simultaneous working is impossible. That the tuning methods will be improved I think there can be very little doubt. The progress that has been made between the year 1896, when it took a week to receive a few elementary signals over a distance of nine miles, and the present time, when such remarkable results have actually been obtained, is so great that it does not imply the possession of an unduly sanguine disposition if one ventures to predict further improvements, which may be expected to increase the freedom from mutual interference, the speed, and the reliability of this method of communication. It does not appear to be very probable that it will seriously compete with the highly-developed cable communication in the near future, although it may in many instances supplement that service."

Passing over some interesting remarks on the development of telegraph-line construction, and the growth of underground cables, Mr. Gavey touches upon the present status of the telephone problem.

"Not the least remarkable of the modern developments of electrical engineering is the extraordinary growth of the telephone service throughout the whole of the world. Subsequent to the year 1860, when Reis invented his musical telephone, it was thought by the majority of electricians that no further approach towards the attainment of articulate speech could be made. The possibilities attending the use of loose contacts, at that time the most dreaded enemy of the electrical engineer, had not been foreseen, and the conclusion was generally arrived at that it would be impossible to devise a transmitter free from the defect of causing actual breaks in continuity so as to admit of the delicate curves necessary for the transmission of articulate speech being reproduced electrically. Bell's invention in 1876 was received almost in a spirit of incredulity, and when in the following year it was brought to this country, it was looked upon as a marvellous development.

"As the result of successive inventions, a steady and rapid improvement in the indoor plant available for exchange work has taken place, and so far as modern telephone switch is concerned, these improvements have been wholly in the direction of reducing the amount of talk on the part of the operator that was necessary under the old conditions. This has been brought about by the provision of a complete system of automatic signalling, whereby she is kept abreast of her work, so that, with the exception of asking for the number of the subscriber who is wanted, there should in all ordinary cases be no need for conversation between the subscriber and the operator, this being accompanied by a corresponding increase in the speed of working. In fact, one system goes so far as to render it unnecessary even to ask for the number of the subscriber required, that information being printed by the caller on a Morse slip. This tendency to reduce the operators to a species of intelligent automaton naturally suggests the possibility of the entire elimination of the operator, and the introduction of suitable automatic apparatus at the exchange. Several very ingenious methods of attaining this end have been devised, and one system has achieved a certain measure of success in America, several exchanges of some magnitude having been equipped with apparatus of this type."

The limits to which speech can be transmitted by telephone have by no means been determined, and in England, as in Germany and the United States, experiments with the Pupin coils have resulted in very materially extending the distance to which clear articulation can be sent. This subject is doubtless open to still further improvement, and no one at present is prepared to make any definite statement as to the limitations of long-distance telephony.

In closing his address Mr. Gavey referred to some of the unsolved problems existing in connection with electrical methods of communication. These include the improvement of high-speed telegraphic systems so as to permit the direct reception of legible records, suitable for immediate delivery to the public or the press.

Another question upon which much labor is being expended is the tuning of receivers in space telegraphy, and still another is the design of an effective telephone relay. The telephone switchboard appears to have reached its limitations in some respects, but the problem of its extension cannot yet be considered as insoluble.

These and many other lines of further development remain open for the electrical engineer, and both in interest and in commercial value they compare fully with the more conspicuous work in the electrical transmission of mechanical energy.

INTERNAL COMBUSTION MOTOR CONSTRUCTION

THE PRESENT PRACTICE OF CONTINENTAL ENGINEERS IN THE DESIGN, CONSTRUCTION AND OPERATION OF GAS ENGINES.

R. E. Mathot—Liége Engineering Congress.

AMONG the valuable papers presented at the International Congress of Mining, Metallurgy and Engineering held in connection with the recent exposition at Liége, we select the communication from M. R. E. Mathot, the well-known expert in internal-combustion motors, since this exhaustive paper gives an excellent résumé of the present state of the art in this important department of engineering.

At the outset M. Mathot calls attention to the consideration which is being given to the four-cycle and the two-cycle forms of motor. So far from advocating either of these to the disparagement of the other, he believes that each has its good features, and that the choice of cycle should be governed by the actual conditions obtaining in any case under consideration.

Four important features are enumerated as involved in the design of an internal-combustion motor: the ignition, the compression, the cooling, and the speed regulation, and these are taken up in order, with examples from the construction of the leading Continental builders.

At the present time the electric spark ignition, using the magneto, is generally employed as being most satisfactory. This system is not only reliable, but especially convenient from the facility with which it permits the use of devices for advancing or delaying the moment of ignition. The only improvement calling for notice is the practice of using two independent ignition devices, with separate spark plugs, this assuring a more uniform ignition of the charge, and providing against accidents.

The subject of compression has attracted much discussion of late, and some engineers are advocating compressions as high as 15 to 16 atmospheres, or 210 to 225 pounds per square inch. The true consideration which should govern the choice of compression is the nature of the gas employed; the degree of compression being such as to avoid all dangers of premature ignition, while at the same time effecting the complete combustion of the charge, however lean the gas employed.

M. Mathot believes that good results will be attained in general by the use of compressions of 9 to 10 kilogrammes per square centimetre, or 128 to 142 pounds per square inch, this assuring an excellent combustion of charges having a calorific power of 550 to 600 calories, or 62 to 67 British thermal units per cubic foot, formed by using 50 per cent. mixtures from suction producer gas of double this calorific power. The presence of hydrocarbons, and particularly of hydrogen, insures a prompt and rapid combustion, even with low compressions.

Tight compressions are generally required for blast-furnace gases, and gases of similar lean composition, and in designing engines for such fuel the degree of compression should be increased in inverse proportion to the calorific power of the fuel.

The refrigeration of the working parts is an inevitable source of loss in efficiency, but, as M. Mathot points out, the heat carried off by the cooling water is in a convenient form for recovery.

The present practice in England, using low degrees of compression, is to jacket the cylinder only, but on the Continent, where higher compressions are used, the exhaust valve is also cooled for engines above 60 horse power, while for sizes of 150 horse power and upwards the water is also circulated through the piston. In the former case from 18 to 20 litres of water are required per horse power per hour, and in the latter from 25 to 30 litres, this being found sufficient to prevent premature ignitions or injurious action to the materials.

The question of regulation of speed is one of the most important elements in gas-engine design, and to it M. Mathot gives much attention.

The old method of "hit-or-miss" governing is now applied only to engines of moderate size, especially in England, while the Continental engineers, followed by the Americans, have availed themselves of more scientific methods. There is no question that the "hit-or-miss" method conduces to a high degree of economy, and that it permits the use of a sensitive governor of small size with a minimum of work to perform. It does not conduce, however, to the smooth and uniform action which the gas engine should have in order to compete effectively with its rival, the steam engine. M. Mathot gives some interesting studies of the action of engines having this type of regulator, using his continuously-recording indicator for presenting an accurate record of the impulses upon the piston.

While the "hit-or-miss" method is applicable to small engines, and has the advantage of permitting the gas mixture to be adjusted once for all, it is manifestly unsuited for the large modern engines, in which a full power stroke, succeeding one or several idle strokes, would produce an undesirable violence of action. It has therefore become necessary to devise some method of more continuous regulation, permitting the use of fly wheels of moderate weight, and permitting a smooth and steady action.

The methods of governing at present employed by the Continental designers are of two principal types. The first of these controls the speed by varying the proportions of the charge, without altering the total quantity admitted. The mechanism of the governor acts upon the gas valve in such a manner as to alter the quantity of gas admitted; the volume of air remaining constant. The result is a variation in the force of the explosion and consequently of the power of the stroke. The principal objection to this method appears in the fact that with light loads the proportion of gas in the charge becomes so low that there is difficulty in effecting the ignition unless the compression is made very high. If the compression is high, however, there is danger of premature ignitions when a full supply of gas is admitted, so that this method of governing appears to be well adapted only for cases in which the variations of load are not great.

The other method of governing is that in which the quality of the charge remains unchanged, the quantity admitted varying according to the demands of the load. In this method either a separate throttling valve is operated by the governor, or else this latter acts upon the mixing valve itself. In either case the proportion of air and gas in the charge remains unchanged, but the total volume entering the cylinder is varied with the load. When the volume of charge admitted is small, as in the case of light loads, the compression will be reduced, so that a fairly high degree of normal compression must be provided in designing engines to be governed in this way. On the whole, it is found to work well in practice, giving smooth action and good economy.

M. Mathot's paper contains some interesting reports of tests of gas engines, and numerous detailed illustrations of the working parts of engines by the principal Continental builders.

MACHINE-SHOP PRACTICE.

THE ARRANGEMENT AND GENERAL MANAGEMENT OF THE MODERN MACHINE SHOP, WITH ESPECIAL REFERENCE TO RAILROAD PRACTICE.

G. M. Campbell—Engineers' Society of Western Pennsylvania.

THE growth of the modern machine shop includes within itself nearly all the elements of progress in mechanical engineering. Motive power, power transmission, machine-tool design and operation, materials of production and construction, building design, applied electricity, both for power and for lighting, all these are included, and to them must be added the management of men, the arrangement and care of rough and finished stores, together with a satisfactory system of finding, distributing and recording costs. It is evident that many of these subjects involve whole series of comprehensive articles themselves for their exemplification, and reference to past issues of this magazine and other technical publications will show many such papers. An excellent presentation of the whole subject in a general way is found in a paper recently presented by Mr. G. M. Campbell, before the Engineers' Society of Western Pennsylvania, and published in the *Proceedings* of the society, and some abstract of this discussion will be found of interest and value.

"The general management of a large machine shop is a subject in itself. The control over the shop should be very complete, and as much a one-man control as possible, not that one man should actually supervise the shop but that he should control every department through competent assistants, each assistant or foreman having trusted foreman or sub-foreman under him. The utmost care should be taken to have all the work performed systematically, so that the time lost in handling work is reduced to a minimum. Again, the utmost care should be taken to turn out good work, for in the end any concern doing poor work is doomed to failure; not only should the workmanship be good, but the parts turned out should all be to gauge within a pre-determined limit of error, the allowable error being determined by means of limit gauges.

"The general scheme of handling the men, whether by day work, piece work, premium or other systems, is also a subject in itself. Each system has advantages and disadvantages. The men should be under careful supervision, but at the same time not watched as if they were trying to cheat the company. A speed foreman or a man whose duty it is to speed up the tools to the proper point is generally obnoxious to the men unless he has exceptional tact. The work can be done by a sub-foreman without the special title. The good will of the men should, as far as possible, be obtained by making the surroundings comfortable and healthy and paying a good wage to keep good men."

Two elements of vital importance in a well managed shop are an efficient tool room and a good stores system.

The tool room itself may be considered as the standard of excellence for the rest of the shop as regards the high class of the machines in it, and the care with which they are operated, while upon the careful arrangement and management of the stores department much of the profit or loss of the establishment will depend.

"One machine—one tool—one man, was the old rule since the operation of the first machine, and if some short-sighted trades unions had their way, would still be in force. But such is no longer the case in live machine shops. Many single spindled drills are, for special work, replaced by multiple spindled drills, so that with one operation half a dozen or more holes are drilled, gaining very greatly in time and also in having the output absolutely interchangeable, a point of the very highest value. Single-headed planers are now the exception except in small sizes; planers cutting on both the forward and return stroke have been used but are not generally approved; plate edge planing machines cut both ways with entire satisfaction. Lathes also have multiple cutting tools, two, three and four. Locomotive driving wheel lathes, for example, can have its two wheels and two bearings machined simultaneously, though duplex machines are the general ones used. Shafting lathes have usually three tools operating, gun lathes, four, etc. Vertical boring mills have usually two heads. Turret lathes in their many modifications are a slightly different example of multiplying tools. The different tools are contained in one machine, but usually one tool operates at a time, the saving in time being effected by the extreme ease of changing from one tool to another."

The general character of the tools in any shop must naturally depend upon the nature of the product. Automatic machines are a paying investment when the number of pieces of one kind is so large that the time required to set the mechanism is small compared to the time the machine will be in operation. The capital and interest should be balanced against the saving in attendance.

Many things formerly done by hand are now performed by machinery. Pneumatic chippers and riveters replace the hand methods; portable grinders and drills take the place of the file and the ratchet, and in many cases it is found easier to take the tools to the work than to set a large piece of work on the machine. The electric traveling crane, with auxiliary localized hoists, takes the place of the large laboring gangs formerly used, and wherever possible the skill of the workman is used rather than the mere exertion of his physical strength.

"The discovery of the value of certain steel alloys is one of the greatest of the age in regard to machine shop practice. Its value is far-reaching, not only in greatly decreasing the time required for an operation but also in leading machine shop men to investigate all connecting problems, such as the strength and better design of machines, the time required for handling and chucking the work, etc. If, under old conditions, a certain operation in a machine required three hours' time and one hour for chucking and handling, the idle time of the machine would be only 25 per cent. of the total, if the time of the operation were reduced by the use of high speed steels to one hour then the idle time would be 50 per cent., and some endeavor would undoubtedly be made to decrease time of chucking. There is a large amount of literature on the subject of these high speed steels, and some of the showings are little short of marvelous compared with former practice. This is especially the case under favorable conditions in experimental demonstrations. Under ordinary conditions the results are less startling, for the problem is not one of speed alone. High speed steel may not always be a paying investment; for example, a light job requiring relatively little time for cutting compared to time required for preparing and chucking; or, again, suppose under ordinary conditions, a man has all he can do attending to two machines, the cutting time of one being just sufficient for the chucking time on the other, then any decrease in cutting time would be of small advantage. In general, the new steels cannot be used to the limit, first, because the present machines will not stand it and the general tendency is to retain present tools, working them to the limit instead of at once scrapping them, and second, much of the work will not stand it on account of special shapes. The old carbon steels give better results, as far as service is concerned, on very light finishing cuts. But on the larger work, shafting, guns, wheel turning, big planing operations, etc., the advantage is enormous. These steels have increased the output of railroad shop machines 25 to 100 per cent., and in some cases even 200 per cent."

Mr. Campbell discusses very fully the

subject of electric driving, and believes that owing to the specialization of motors the multi-voltage system of speed control may be replaced by the use of field controlled motors. He is distinctly in favor of individual motor driving as opposed to the group system, and gives practical data to show that the advantage of economy does not necessarily lie with the latter method.

The paper contains an excellent description of the electric power system at the shops of the Pittsburgh and Lake Erie shops at McKees Rocks, near Pittsburgh, with tabulated results of cutting speeds of lathes, planers, and other tools, on cast iron, steel, wrought iron, and brass, with data concerning the general output of the works.

MARINE GAS ENGINES.

APPLICATIONS OF INTERNAL-COMBUSTION MOTORS TO THE PROPULSION OF BOATS IN COMMERCIAL SERVICE.

C. Stein—Verein Deutscher Ingenieure.

WITH the general development of the large gas engine there has come a natural tendency to apply it as a motor to nearly every variety of machinery demanding the effort of mechanical energy. It is to be expected, therefore, that the combustion motor, in more than one type, should be applied to the propulsion of boats; not only for driving the small, high-speed pleasure craft, but also vessels of larger size and less pretensions as to speed.

An article by Herr C. Stein in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure* reviews the practical applications which have been made of gas engines for propelling commercial vessels, and although the subject is in an early stage of its career it already demands attention and review.

The earliest attempts to use internal-combustion motors for marine service involved the carrying of compressed illuminating gas, a freight boat called *L'Idée* having been so equipped to run between Havre, Rouen, and Paris in 1895. The gas was compressed to 100 atmospheres, there being 80 tanks, each holding 22 cubic metres of gas, the total volume of gas carried being 1,800 cubic metres. The 40 horse power engine consumed 450 litres of gas per horse-power per hour; giving a speed of 10 kilometres per hour, for 100 hours, or a radius of action of 1,000 kilometres. The gas tanks themselves weighed 26,000 kilogrammes, and Herr Stein computes that this weight, if replaced by a tank of petroleum, would supply fuel for 1,200 hours, or twelve times the period obtained with compressed gas.

By the use of modern benzine or gasoline motors the question of fuel is readily solved, and some very successful motors of this type have been made for marine use. All such motors involve certain modifications to be made in the propelling machinery in use for steam propulsion, and these points are very fully discussed in Herr Stein's paper. Thus the gas engine is not easily reversed, and should be operated regularly at its normal speed, the speed changes being controlled by other means than by varying the velocity of the engine.

Reversals are effected either by changing the angle of the propeller blades, or by the use of reverse gearing, changing the direction of revolution of the propeller shaft. The shifting propeller blades are not found to work well for larger powers than 100 horse power, although this method is satisfactory for small boats. Herr Stein illustrates several arrangements of clutches and gearing for reversing the propeller shaft, some of these being combined with a pivoted tail shaft, so that the propeller can be raised out of the water when proceeding under sail.

The use of gasoline motors for marine service is necessarily limited, and hence the practicability of employing producer gas becomes a matter for interest. The development of the suction gas producer offers opportunity for the arrangement of a complete power gas plant for such a service, and Herr Stein describes such an equipment on a freight boat navigating on the Elbe. This boat, the *Lotte,* is 41 metres long, 4.6 metres beam, drawing 2 metres with a load of about 240 tons. This boat is fitted with a pair of balanced gas engines, the cylinders having the *vis-à-vis* arrangement, the suction gas producer being placed in an adjoining compartment, in order to protect the moving parts from the heat and dust. The engines develop about 100 horse power, this sufficing to propel the boat at a speed of about six kilometres per hour against the current. Experiments with this and other boats propelled by suction gas power show that the cost of transport falls as low as 0.64 pfennig per ton-kilometre, or about 0.25 cents per ton mile, as against 1 pfennig for steamboat transport, and 3.2 pfennigs on the railway.

The suction producer is especially applicable for use on shipboard, since an unlimited supply of water is available for condensing the impurities, tar, and other volatile matter in the gas, and there is also ample opportunity for keeping the cylinders of the motors properly cooled. In general the conditions for operating the internal-combustion motor are far more favorable on shipboard than on road vehicles. The question of weight is not of such controlling importance, and hence the various parts may be made of ample strength. The difficulties from dust and dirt are absent, while the working parts may be made readily accessible. At the present time the larger sizes of gas engines have not been applied to marine propulsion, but for the propelling of boats of moderate size at the speeds common for ordinary river transport the engines now available have already proved their capability and high economy.

The Diesel motor has also been applied to marine propulsion, and it has the especial advantage of using heavy oil, petroleum, and similar fuels directly in the cylinder, without requiring any carburetter. The high thermal efficiency of the Diesel motor naturally renders it especially desirable for vessels in which the radius of action is extended in proportion to the efficiency with which the fuel is converted into mechanical power.

Gas-engine propulsion for boats may be said to be yet in its infancy, but the results thus far attained have been most encouraging, and there is every reason to believe that the use of internal-combustion motors on shipboard will become widely extended.

TECHNICAL EDUCATION

PRACTICAL RESULTS FROM THE APPLICATION OF TECHNICAL EDUCATION TO ENGINEERING WORK.

John Goodman—Manchester Association of Engineers.

THERE is no longer much doubt in the minds of practical men in either Europe or America as to the real value of a technical training, although some men are disposed to believe that its advantages have been overrated. The whole subject is discussed in a very illuminating manner in a paper recently read by Professor Goodman before the Manchester Association of Engineers, and some abstract of this address will be found of much interest.

Taking up first the subject of the scope of technical education, it is shown to involve the systematic classification and use of facts.

"Sometimes our facts are meagre and only cover a narrow range of phenomena, and the conditions are highly complex, which thus prevents us at the outset from doing much classification, or even tracing the connection between our observed phenomena and the first principles of our science; therefore, as a first approximation, we have to be content with an imperfect law or statement known as an empirical formula. Such a proceeding is not strictly scientific, and if such a formula be applied to conditions outside those covered by the limited range of facts on which it is based it may lead to serious blunders: many of the discrepancies between theory and practice can be traced to such an improper use of empirical formulas.

"When our law or formula covers a very wide range of observed phenomena and rests moreover on the fundamental principles of science, whose truth has been abundantly established, the formula is known as a rational formula, and the process of obtaining and using such a formula comes within the category of scientific treatment. The scientific treatment of a subject therefore amounts to the bringing of a concentrated experience to bear on the matter under consideration.

"Before a rigid scientific treatment is possible, the question under consideration must be cleared of all side issues and must be reduced to its simplest form; any conditions which tend in any way to hide the main point at issue are liable to be productive of errors. In laboratory experiments, naked or fundamental conditions can usually be arranged and the results be rigidly stated, but in practice side issues are often of great importance; errors of judgment then enter into the problem and may bring about discrepancies between the imperfect theory and practice. Those who most severely criticise the existence of these discrepancies are usually those who know least of the difficulties to be encountered.

"A technically educated engineer is keenly alive to the importance of side issues, and is constantly on the alert in making observations, collecting and classifying all data that will enable him in the future to adjust his formulas to fit practical conditions. Once having acquired the scientific mental attitude he will ever be athirst for knowledge and for data to throw light on the problems that confront him: it is this mental attitude that technical teachers aim at imparting to students.

"Those therefore who have acquired this attitude, gain experience much more rapidly than those who have not had the advantage of a technical training. This capacity for rapidly gaining experience is believed to be the most important result of technical education; in short, it teaches students to *observe* as well as *see*.

Professor Goodman takes such data as are available and plots curves showing the average income earned by engineers having a technical training, as compared with those without a technical education. A comparison of the two curves shows that while the man without the technical training first takes the lead, doubtless owing to his earlier start, he is soon overtaken and rapidly distanced by his better educated rival. In this respect the diagrams drawn by Professor Goodman resemble very closely those of a similar nature prepared a few years ago by Mr. James M. Dodge in a paper presented before the American Society of Mechanical Engineers, and it is an interesting confirmation of Mr. Dodge's conclusions to find them so fully borne out by data from an entirely different and independent source.

"It is a matter of common knowledge that there are many shrewd practical men who will not employ men of high technical attainments. They openly state that they prefer draughtsmen and managers who have very little, if any, scientific knowledge of engineering. This attitude is partly due to prejudice and partly to the fact that technically educated men often make themselves unpopular for one or more of the following reasons: They suffer from swelled heads and are very apt to compare their academic knowledge and methods with those of their employer or senior in the profession to the disparagement of the latter. They forget that his theoretical knowledge has probably got rusty through giving attention to other but equally important work for many years. Even if their seniors have never been possessed of such knowledge they are nevertheless entitled to the highest respect in virtue of other knowledge they possess of which the conceited youngster straight from college knows nothing. The college trained youth seems to forget too that the nomenclature of science to-day is very different from that in vogue a generation ago when their seniors were trained; hence many of the older engineers may have a very intimate knowledge of the theoretical side of engineering and yet know but little of the scientific technical terms used at the present day. The technical knowledge possessed by the raw student may not be in such a form as to be of much or of any service to him in actual engineering work. One occasionally meets highly mathematical men who lack all sense of proportion as regards the accuracy required for every-day purposes. They prefer a long, but apparently exact, mathematical treatment to a short cut which is sufficiently accurate for all practical purposes. Such men give one the impression that they would rather have a tooth drawn than make use of a convenient approximation."

Many of the defects of technical training are doubtless due to the work of teachers who have no real practical knowledge of their subjects. By an insufficiency of business knowledge, and an unfamiliarity with actual methods employed in the workshop and field they leave essentials untaught, and the student must supply the deficiencies of such training by his own later experience. The best remedy for this state of affairs is one which has been applied with success in the United States, that is, by permitting, and even encouraging the professor to undertake outside work, and thus keep himself in touch with current practice. The plan of having eminent engineers as special lecturers is also an excellent method of bringing the actual working conditions of engineering practice before the students.

"Technical education is largely responsible for the improved position that engineering now occupies. For a long time it was regarded as a mere mercantile pursuit; then science was brought to bear upon the work of the engineer, and engineering now occupies the position of a learned profession whose exacting demands are fully recognised.

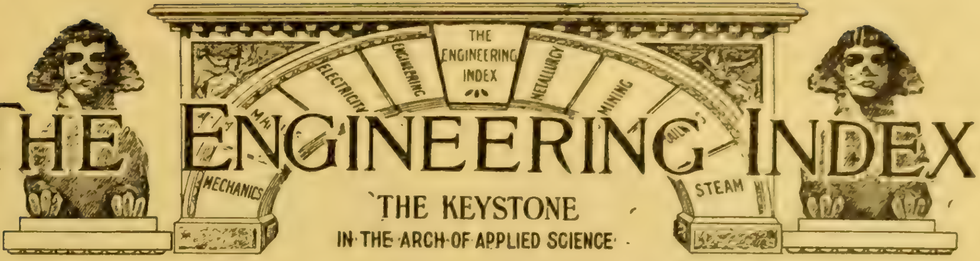
"Technical education has enabled gigantic engineering schemes to be successfully carried through which would have been quite impossible under the old rule of thumb régime. As a notable example we may cite the Forth Bridge.

"Technical education has done much towards reducing the cost of production. The cost of designing is less because the design is arrived at by a direct process which is necessarily quicker than the old trial and error method. The cost of material is less, because more suitable materials are now procurable (thanks to the scientific metallurgists) and because there is less waste, the exact amount required in each case being arrived at by calculation. The cost of manufacture is reduced, due to improved lifting appliances, to better machine tools, and to high speed steel, all of which owe their existence directly or indirectly to technical knowledge.

"Technical education enables the designer to turn out novel and improved designs. Some branches of technical education, of little value in themselves, are invaluable as aids to training the imagination—the very root of novelty in design.

"Technical education has the effect of rapidly developing and maturing inventions, a point sometimes of the highest importance, not only to the trade and profession of engineering, but also to the country itself. If a comparison be drawn between the development of the reciprocating steam engine and that of the steam turbine we find that for nearly two centuries the steam engine made practically no progress in the hands of men who had no pretence to a knowledge of science, whereas it progressed by leaps and bounds under the scientific treatment of Watt, Hirn, and others, who were pioneers in the application of thermodynamics to the steam engine. In the case of the steam turbine however, scarcely a quarter of a century has elapsed since that highly scientific and brilliant engineer Mr. Parsons invented a practical form of this machine, and to-day we have it as near perfect as it is every likely to be. We think we are justified in expressing this opinion, since the steam consumption of a turbine closely approaches the minimum possible in a theoretically perfect steam engine. Even the most bigoted of practical men will not pretend for one moment that the enormous difficulties encountered in the development of the steam turbine could ever have been surmounted without the aid of science, and we may go so far as to say that no firm can even follow in Mr. Parsons's footsteps and manufacture a satisfactory turbine to-day without the aid of scientific men in the form of draughtsmen or managers.

"To take another instance—the development of the internal combustion engine, which many far-seeing men believe will in the near future supplant the steam engine. Its birth as a practical machine is well within the memory of many of us, although many experimenters, groping in the dark, had previously dabbled with it; the problem was not solved until a highly trained doctor of philosophy in Germany took the matter in hand and from a noisy, troublesome, uncertain toy produced one of the most useful and efficient heat motors known. But great as was Dr. Otto's work, still greater perhaps was that of Diesel, who, from a purely theoretical standpoint attacked afresh the problem of the internal combustion engine and at one sweep nearly doubled its heat efficiency, or in other words nearly halved its fuel consumption.



THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Computations for a Masonry Arch (Sur le Calcul d'Une Arche en Maçonnerie). M. Auric. Deriving equations for the ready calculations of the stresses in an arch of cycloidal curve. 800 w. Comptes Rendus—Oct. 16, 1905. No. 73325 D.

Masonry Arch of 90 Metres Span (Pont en Maçonnerie de 90 Mètres d'Ouverture). A. Bidault des Chaumes. An illustrated description of the great arch at Plauen, in Saxony, comparing it with the Luxembourg arch. 2000 w. 1 plate. Génie Civil—Nov. 4, 1905. No. 73316 D.

Parabolic Concrete Arch Bridge Over Piney Creek at 16th St., Washington, D. C. Illustrated detailed description of a bridge of unusual type. The arch ring has the curve of a parabola and a clear span of 125 ft. 3000 w. Eng News—Nov. 16, 1905. No. 73219.

The Plauen Viaduct. An illustrated description of this viaduct, the arch ring having the largest constructive span ever built in stone. 1700 w. Engr, Lond—Oct. 27, 1905. No. 73011 A.

Bengal.

The Damodar Coal-line Bridge: Midnapur-Jherria Extension of the Bengal-Nagpur Railway. William Oswald Taylor. Illustrated detailed description of the construction of a bridge consisting of 5 spans of 150-foot, one span of 100-foot, and one span of 40-foot steel girders, for a single line of rails, on masonry piers. 4200 w. Ills. (No. 3512.) Inst of Civ Engrs. No. 73182 N.

Floors.

Proposed Concrete Floors for Railway Bridges and Tracks. J. W. Schaub. Illustrates and describes a proposed design in which the track rests on a longitudinal timber bolted to a concrete floor. 1000 w. Eng News—Nov. 2, 1905. No. 72959.

Lattice-Girder.

The Determination of the Stresses in Lattice-Girder Bridges when Subjected to Concentrated Travelling-Loads, and the Effect of Replacing These Loads by "Equivalent Loads." Frederick Charles Lea. Discusses a simple but accurate method of determining these stresses, considering a number of special cases. Ills. 8200 w. (No. 3539.) Inst of Civ Engrs. No. 73172 N.

London Bridge.

The Widening of London Bridge. William Bartholomew Cole. Reviews the various movements for widening this bridge, which was opened in 1831, and the final work of widening the footways. Ills. 8500 w. (No. 3518.) Inst of Civ Engrs. No. 73171 N.

New York.

Williamsburg Bridge, New York. Frank W. Skinner. Illustrated description of this bridge and its construction, explaining the location and conditions and briefly describing the companion bridges. 6000 w. Engng—Oct. 18, 1905. Serial. 1st part. No. 73007 A.

Poughkeepsie.

Reinforcing the Poughkeepsie Bridge. Describes the high-level, double-track deck structure across the Hudson River, completed about 20 years ago, and the improvements to be made to meet present requirements. 1700 w. Eng Rec—Oct. 28, 1905. No. 72906.

Reinforced Concrete.

Reinforced - Concrete Bridges with Gravel Roadway (Betoneisenbrücken für Beschotterte Strassen). Anton Kraupa. Illustrating arrangements of structural beams imbedded in concrete and carrying highways. Computations for various loadings are given. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—Oct. 28, 1905. No. 73365 D.

Suspension.

Chains vs. Cables in the Manhattan Bridge. Wilhelm Hildenbrand. A letter giving arguments and explanation of the calculations on which the writer based his views. Also editorial. 3500 w. Sci Am—Nov. 4, 1905. No. 72967.

The Design of the Post Base of the Manhattan Bridge Towers. Gives an illustrated description of the tower post of this suspension bridge across the East River, New York, designed for very heavy loads. 2000 w. Eng Rec—Nov. 25, 1905. No. 73497.

Viaducts.

On the Construction of a Concrete Railway-Viaduct. Arthur Wood-Hill, and Edward Davy Pain. An illustrated detailed account of the construction of a concrete viaduct at Cannington, Eng., consisting of 10 elliptical arches, the total length being 600 ft. Ills. Discussion, and correspondence. 23000 w. (No. 3502.) Inst of Civ Engrs. No. 73150 N.

The Fades Viaduct. E. Ommelange. Illustrated detailed description of this viaduct under construction in France, which will be the highest railroad bridge in the world. 1000 w. R R Gaz—Vol. XXXIX., No. 21. No. 73432.

Zambesi.

The Opening of the Victoria Falls Bridge. Harold Shepstone. An illustrated account of the opening of this bridge over the Zambesi gorge in central Africa. 1000 w. Sci Am Sup—Nov. 4, 1905. No. 72969.

CONSTRUCTION.

Alterations.

Steel Details in the Alterations of the Judge Building. Brief illustrated description of extensive improvements carried out without disturbing the tenants of the building. The building was raised four additional stories, and a heavy interior wall which carried the ends of the floor beams was removed. 1000 w. Eng Rec—Nov. 11, 1905. No. 73143.

Building Construction.

The New Altman Building, New York. Describes the construction of this fine department store at 5th Ave., 34th and 35th Sts., giving details of the steelwork. 1200 w. Eng Rec—Nov. 4, 1905. No. 73063.

Building Details.

Structural Details in a Maiden Lane Building. Illustrates and describes details of a steel-cage building, eleven stories and basement, in New York. 1600 w. Eng Rec—Nov. 18, 1905. No. 73254.

Excavator.

A Submarine Rock Excavator. Charles Graham Hepburn. Describes an apparatus, designed and built in New South Wales, for the purpose of wharf-building and operations on submarine rock. Ills. 1000 w. (No. 3469.) Inst of Civ Engrs. No. 73165 N.

Foundations.

Corrugated Concrete Foundation Piles. Describes briefly the method adopted for foundations of the Lattemann Building, Brooklyn, intended for use as a shoe factory. 1000 w. Eng Rec—Nov. 11, 1905. No. 73142.

Sinking a Foundation Caisson with Post-Hole Augers. Illustrated description of unusual construction at the General Electric Co.'s works at Schenectady, to build engine foundations in quicksand. 600 w. Eng Rec—Nov. 18, 1905. No. 73249.

Sinking Machinery Foundations in Quicksand Without Excavation. Describes an ingenious and novel method of constructing foundations for a 60-ft. boring mill at the General Electric Co.'s plant, at Schenectady. 1000 w. Eng Rec —Nov. 4, 1905. No. 73065.

Unusual Foundations at the Hoboken Terminal of the Lackawanna R. R. Outlines conditions and gives an illustrated detailed description of the foundation work. 2000 w. Eng Rec—Nov. 11, 1905. No. 73141.

Naval Station.

Structural Features of the New Buildings at the New Orleans Naval Station. L. F. Bellinger. Illustrations with brief description. 700 w. Eng Rec—Oct. 28, 1905. No. 72909.

Reconstruction.

Reconstruction of the Mercantile Building, New York City. Illustrates and describes the methods used in adding six more stories, and building a steel-cage addition on the East Side. 3300 w. Eng Rec—Oct. 28, 1905. No. 72910.

Reinforced Concrete.

A Reinforced Concrete School Building. Illustrates and describes a very beautiful private school building in New York. 1400 w. Archts' & Bldrs' Mag—Nov., 1905. No. 73261 C.

Reinforced Concrete Building, for the Park Square Motor Mart, Boston. G. H. Brager. Illustrated description of a building under construction for the storage of motor vehicles. 1800 w. Eng Rec—Nov. 18, 1905. No. 73251.

Revetment.

Concrete Revetment for a 200-Foot Cliff, Niagara River Gorge, Niagara Falls, N. Y. Illustrated description of a revetment being built for the rock cliff. 500 w. Eng News—Nov. 2, 1905. No. 72960.

Tunnels.

I. Alfreton Second Tunnel. Ernest Frederick Crosbie Trench. (No. 3380.) II. The Reconstruction of Moncreiffe Tunnel. Dugald McLellan. (No. 3498.) With an abstract of the discussion on the two papers. Illustrated descriptions of the construction work. 22500 w. Inst of Civ Engrs. No. 73155 N.

Timber Tunneling in Quicksand. Rufus K. Porter. Describes in detail the method employed in constructing a sewer in the city of Newton, Mass., 500 ft. of which was built in timbered tunnels. Also general discussion. 5500 w. Jour Assn of Engng Soc's—Aug., 1905. No. 73029 C.

Tunnel Boring in Ancient Palestine. Brief account of tunnels built 2,500 years ago by means of which water was brought to ancient cities. 600 w. Sci Am—Nov. 4, 1905. No. 72965.

Underpinning.

Transferring a 2,000-Ton Wall to Columns and Girders. Illustrated description of a method of underpinning used for a heavy wall. 1200 w. Eng Rec—Nov. 4, 1905. No. 73064.

MATERIALS OF CONSTRUCTION.

Cement.

A Comparison of the Recent British and American Specifications for Cement. R. W. Lesley. Abstract of a paper read before the Am. Soc. for Test. Materials. 1300 w. Eng News—Nov. 16, 1905. No. 73223.

Compression.

Some Experiments for Determining the Elastic and Ultimate Strength of Brickwork Piers and Pillars of Portland-Cement Concrete. William Charles Popplewell. Describes tests carried out and gives conclusions. 3800 w. (No. 3549.) Inst of Civ Engrs—No. 73169 N.

The Compressive Resistance of Blocks and Columns of Concrete and Stone. Describes tests made which show the importance of considering the lateral and tensile stresses as well as the compressive force. Ills. 2400 w. Cement—Nov., 1905. No. 73109 C.

Concrete.

German Specifications for Designing, Constructing and Testing Concrete Structures. Leon S. Moisseiff. Gives the full set of specifications recommended for adoption by a committee of the German Concrete Society. 4500 w. Eng News—Nov. 9, 1905. No. 73080.

Some Remarkable Tests Indicating "Flow" of Concrete Under Pressure. Ira H. Woolson. Illustrated account of some rather extraordinary results obtained in the Columbia Univ. Test. Laboratory. 600 w. Eng News—Nov. 2, 1905. No. 72958.

Concrete Blocks.

Concrete Block Construction and the Architects. Editorial discussion of this material, the shortcomings of the block maker, and the neglect of the architect. 1700 w. Eng News—Nov. 23, 1905. No. 73425.

The Manufacture of Concrete Blocks and Their Use in Building Construction. H. G. Richey. Third prize paper. Considers points of importance in the manufacture and construction. Ills. 7000 w. Cement Age—Nov., 1905. No. 73266.

Fire Tests.

Fire Tests with Concrete and Reinforced Concrete. An account of the fire and water tests conducted by the British Fire-Prevention Committee. 1800 w. Engng—Nov. 17, 1905. No. 73482 A.

Reinforced Concrete.

Breaking Tests of Reinforced Concrete Structures. Illustrated report of tests made of various structures at the exhibition of the German Municipalities at Dresden, at the time of their removal. 3000 w. Cement—Nov., 1905. No. 73108 C.

Reinforced Concrete Applied to Modern Shop Construction. E. N. Hunting. States the advantages of this material, showing how well it is adapted to shop construction; also gives some data on actual work of this class. Ills. 1800 w. Trans Am Soc of Mech Engrs (No. 083) —Dec., 1905. No. 73439 C.

Shearing.

Shearing Forces Due to a Uniform Advancing Load on Beams and Braced Girders. Prof. W. E. Lilly. A solution of the maximum shearing stresses in the bracing of girders under a uniform advancing load equal in length to the span. 500 w. Engng—Nov. 10, 1905. No. 73286 A.

Sheet Piling.

American Steel Sheet Piling. Illustrated descriptions of a number of designs used for cofferdams, mine shafts, wells for foundation piers, and general foundation work. 1100 w. Engr, Lond —Nov. 3, 1905. No. 73136 A.

Steel Sheet Piling. Describes recent work where this material has been used. 1700 w. Eng News—Nov. 23, 1905. No. 73423.

Timber.

The Inspection of Treatment for the Protection of Timber by the Injection of Creosote Oil. H. R. Stanford. Treats only of the quantity of oil which is injected, and is based on tests and observations made upon yellow pine treated for use in engineering structures in Pensacola Bay. 2500 w. Pro Am Soc of Civ Engrs—Nov., 1905. No. 73437 E.

MEASUREMENT.

Earthwork.

The Determination of Profiles in Excavation and Embankment Work of Trapezoidal Section (Beitrag zur Konstruktion des Flächenprofiles bei Trassierung von Verkehrswegen mit Trapezoidischem Querprofile des Kunstkörpers). Karl Allitsch. Deriving a graphical method, with table to facilitate the work. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—Nov. 4, 1905. No. 73366 B.

Surveying.

Meridian Diagrams. Charles Arthur Albert Barnes. Describes certain practical methods which have proved satisfactory. 1700 w. (No. 3531.) Inst of Civ Engrs. No. 73173 N.

Methods of Rod-Holding in Stadia Surveying and Description of a New Stadia Slide Rule. Arthur L. Bell. Describes the two methods of rod or staff holding now in use, and the circular slide rule for reducing stadia readings designed by the writer. Ills. 2500 w. Eng News—Nov. 9, 1905. No. 73082.

MUNICIPAL.

Curbs.

Suggestions Covering Combined Curb and Gutter. Albert Moyer. Gives outlines for specifications for the manufacture of monolithic cement stone. 1800 w. Eng Rec—Nov. 4, 1905. No. 73060.

Destructor.

The Combined Rubbish Destructor and Power Plant in New York. An illustrated detailed description of the Williamsburg bridge plant, its equipment and operation. 4000 w. Eng Rec—Nov. 11, 1905. No. 73139.

Sewage Disposal.

Progress in the Work of Turning Chicago's Sewage Away from Lake Michigan. Editorial review of the present situation, and the work in progress on the intercepting sewer system 1400 w. Eng News—Nov. 9, 1905. No. 73084.

Reflections on Sewage Farming Suggested by Experiences at Reading, England. Editorial on sewage treatment and a review of a report on the operation of the Reading sewage farm. 3000 w. Eng News—Nov. 16, 1905. No. 73222.

The Operation of the Sewage Works of Manchester, England, 1904-5. A report of the operation of remodelled sewage works. 1700 w. Eng News—Nov. 2, 1905. No. 72964.

The Tankage of Sewage. F. Wallis Stoddart. Read before the Roy. Inst. of Pub. Health. A discussion of sewage treatment, describing experiments showing the effect of rate of flow, tank capacity, &c. 4200 w. Eng Rec—Nov. 18, 1905. No. 73252.

Sewage Pumping.

Notes on the Working of the Shone System of Sewerage at Karachi. James Forrest Brunton. An account of trials, made with a view to ascertain the cause of the unsatisfactory working of the installation, with the results. 3300 w. Tables and diagrams. (No. 3436.) Inst of Civ Engrs. No. 73148 N.

The Sewage Pumping Station at the Hampton Institute. An illustrated detailed description of a sewerage system designed to serve about 1,000 people, living and working in separate buildings over a considerable area. 2500 w. Eng Rec—Nov. 18, 1905. No. 73248.

The Thirty-Ninth Street Sewage Pumping Station, Chicago. Illustrated detailed description of a station having a rated capacity of 900,000 gal. a minute. 4500 w. Eng Rec—Nov. 18, 1905. No. 73253.

Sewers.

Breakage in Sewer Pipes. Information from a paper by Mr. Alexander Potter, of New York, read before the Boston Society of Civil Engineers. 1600 w. Eng Rec—Oct. 28, 1905. No. 72907.

The Broadway Outfall Sewer, Borough of the Bronx, New York. Illustrates and describes the twin sewer built to carry the combined sewage and storm water flow from the watershed of Tibbitt's Brook. Describes the construction. 2500 w. Eng Rec—Nov. 11, 1905. No. 73144.

The Sewerage of Douglas, Isle of Man. Edmund Herbert Stevenson, and Edward Knaston Burstal. A brief history of the sewerage of Douglas, with a description of the existing system recently carried out by the authors. Discussion. Ills. 14000 w. (No. 3510.) Inst of Civ Engrs. No. 73149 N.

Vitrified Tile Sewers as House Drains in Chicago. Perry L. Hedrick. States the conditions in Chicago, quoting from plumbing ordinances, and showing that a careful workman can lay a tile sewer so as to make it water tight and to withstand the specified pressure. 2000 w. Eng News—Nov. 2, 1905. No. 72957.

Sunlight.

The Orientation of Buildings and of Streets in Relation to Sunlight. William Atkinson. A study of the subject in relation especially to hospital architecture, but applicable to residences. Ills. 5700 w. Tech Qr—Sept., 1905. No. 73028 E.

WATER SUPPLY.

Artesian.

The Artesian System of Western Queensland. Cyrus John Richard Williams. Information concerning the water-bearing beds, the flowing and non-flowing wells, and related matter of interest. 1500 w. (No. 3490.) Inst of Civ Engrs. No. 73174 N.

Farm Supply.

Water Supply for Farm Buildings. An illustrated description of work and an account of how it was secured and erected. 1500 w. Met Work—Nov. 18, 1905. No. 73208.

Filtration.

A Modern Filter Plant. Freeland Howe, Jr. Illustrates and describes the installation of mechanical filters at Danville, Va., giving details and results. 1200 w. Munic Engng—Nov., 1905. No. 72916 C.

Report of Board of Investigating Engineers on the Philadelphia Filtration and Boulevard Contracts. Gives full report of the committee appointed to investigate all matters relating to the work on the city's new filtration plant and boulevard system. 11000 w. Eng News—Nov. 2, 1905. No. 72962.

Ground Water.

The Flow of Water into Wells and Excavations (Ueber den Wasserzudrang in Brunnen und Baugruben). Dr. Philipp Forchheimer. An examination of the influence of pressure due to underground currents in connection with the filling of wells. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 27, 1905. No. 73329 D.

Intake.

An Old Wood Stave Water Intake at Quincy, Ill. Edward Prince. Illustrates and describes a pipe, laid in 1887, and still in perfect condition. 900 w. Eng News—Nov. 2, 1905. No. 72961.

Pipe Corrosion.

Guarding Against Electrolysis of Underground Pipes. Putnam A. Bates. Gives results of recent tests made in a large town near New York, to determine the condition with regard to the presence of leakage currents from the grounded circuit of the local traction company. 2000 w. Elec Rev, N Y—Nov. 11, 1905. No. 73114.

Pumping Plant.

The Turbine Pumping Plant of the Buffalo Water Works. An account of extensive improvements, including the installation of eight 25,000,000-gal. vertical two-stage turbine pumps, each connected to an electric motor. 1300 w. Eng Rec—Oct. 28, 1905. No. 72908.

Pumps.

See Mechanical Engineering, Hydraulics.

Reservoirs.

Sheet Steel Piles in Reservoir Construction. Describes a reservoi· near New Milford, New Jersey, explaining the conditions. Ills. 1200 w. Eng Rec—Nov. 18, 1905. No. 73250.

The East Canyon Creek Reservoir, Morgan Co., Utah. William M. Bostaph. A brief history of this irrigation enterprise and an illustrateed description of the work. 3200 w. Eng Rec—Nov. 25, 1905. No. 73495.

Springs.

The Hot and Mineral Springs of Routt County and Middle Park, Colorado. A. Lakes. An illustrated description of interesting and valuable springs, which will probably become very important in the future. 1200 w. Min Rept—Nov. 2, 1905. No. 73041.

The Scherrer Method of Impounding Mineral Springs (Die A. Scherrersche Mineralquellen - Fassungsmethode). F. Müller. A review of methods of collecting any one of several sources of underground water, showing the practicability of capping the veins of water in the rock. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 3, 1905. No. 73330 D.

WATERWAYS AND HARBORS.

Canals.

The Bridgewater Canal Navigations. Walter Hartley Wiswall. Information concerning this 40 mile canal in England. 700 w. (No. 3504.) Inst of Civ Engrs. No. 73163 N.

Coast Erosion.

I. Coast Erosion. Alfred Edward Carey. (No. 3493.) II. Erosion on the Holderness Coast of Yorkshire. Ernest Romney Matthews. (No. 3495.) With an abstract of the discussion on the two papers. In the first paper the author considers from an administrative rather than from an engineering standpoint, the measures to be adopted for defence against such encroachment. The second paper describes the remedial works executed or suggested. Ills. 5400 w. Inst of Civ Engrs. No. 73154 N.

Docks.

The Graving Docks of Hong Kong. Albert Denison. Short descriptions of the docks built and under construction. 1000 w. (No. 3492.) Inst of Civ Engrs. No. 73166 N.

The New Bombay Docks. Information concerning the work in progress for increasing the dock facilities, and some of the difficulties to be overcome. 2500 w. Engr, Lond—Nov. 10, 1905. No. 73293 A.

Dredging.

Dredging and Dredging Appliances. Brysson Cunningham. The present article illustrates and describes types of dipper and ladder dredges. A concluding article will be devoted to grab and hydraulic dredges. 2500 w. Cassier's Mag—Nov., 1905. Serial. 1st part. No. 72990 B.

Government Dredge for Delaware River. Illustrated detailed description. 1200 w. Marine Engng—Nov., 1905. No. 72914 C.

Harbor Works.

Seaham Harbor New Works. Illustrates and describes the important engineering works, recently completed, for the improvement of this harbor and docks. 1600 w. Engr, Lond—Nov. 10, 1905. No. 73298 A.

Hooghly.

The River Hooghly. Leveson Francis Vernon-Harcourt. An account of this very interesting branch of the Ganges, founded upon very careful investigations, and a study of all the available charts. Ills. 41500 w. (No. 3478). Inst of Civ Engrs. No. 73151 N.

New South Wales.

Improvements at the Entrance to the Richmond River, New South Wales. Thomas Edward Burrows. Gives an account of the works carried out or in course of construction, in accordance with the recommendations of the late Sir John Coode. 5400 w. Ills. (No. 3503.) Inst of Civ Engrs. No. 73180 N.

Niagara.

The American and Canadian Channels of Niagara Falls. Alton D. Adams. An illustrated description of the two channels with remarks on the effect of further diversions of water above the falls. 2000 w. Elec Rev, N Y—Nov. 11, 1905. No. 73115.

Orinoco.

The Orinoco—A Wasted Waterway. G. L. M. Brown. Illustrated description of this remarkable river, its peculiarities, the vessels that navigate it, &c. 2200 w. Sci Am—Nov. 25, 1905. No. 73415.

Overflow.

The Levee and Drainage Problem of the American Bottoms. Edwin G. Helm. Discusses the protection from overflow of the Mississippi River and the drainage of the interior waters of the American Bottoms. 11700 w. Jour Assn of Engng Socs—Sept., 1905. No. 73484 C.

Panama.

An Engineer's Life in the Field on the Isthmus. Fullerton L. Waldo. A well illustrated account from actual experience on the canal work; together with a hitherto unpublished report on the Gamboa

Dam. 6000 w. Engineering Magazine—Dec., 1905. No. 73372 B.

Progress on the Panama Canal Work. Information from the address of Hon. William H. Taft, before the St. Louis Commercial Club. Especially concerning the troubles and difficulties experienced during the last two years. 7200 w. Eng News—Nov. 23, 1905. No. 73424.

The Panama Contretemps. Editorial discussion of the present situation. 1800 w. R R Gaz—Vol. XXXIX., No. 21. No. 73430.

The Panama Water and Sewerage Works. An illustrated article describing the condition of the City of Panama before the treaty with the United States, and the work that has been done since in the water supply and sewerage departments. 2000 w. Eng Rec—Nov. 25, 1905. No. 73493.

The Real Conditions at Panama. Eugene P. Lyle, Jr. The second of a series of investigations of the problems involved in the control of the canal. 6800 w. World's Work—Nov., 1905. No. 72923 C.

What Has Been Accomplished at Panama. Theodore P. Shonts. Extracts from an address before the Am. Hardware Mfrs.' Assn. Discusses the sanitation of the Isthmus, and the providing of suitable habitations for all classes of employees, and the food supply. The difficulties to be overcome are explained. 3000 w. Eng News—Nov. 16, 1905. No. 73220.

Water Flow.

See Mechanical Engng, Hydraulics.

ELECTRICAL ENGINEERING

COMMUNICATION.

Address.

Presidential Address to the Institution of Electrical Engineers. John Gavey. Principally a discussion of telegraphy and telephony, and their problems. 12800 w. Elect'n, Lond—Nov. 10, 17, 1905. Serial. 2 parts. No. 73459 each A.

Arizona.

Telephone Engineering in "The Country God Forgot." George Bond Ellison. An amusing account of difficult work in Arizona. Ills. 3500 w. Jour of Elec—Nov., 1905. No. 73068 C.

Coherers.

Theory of Coherer Action. From the *English Mechanic and World of Science.* Briefly discusses the theeories advanced by Lodge, Branly, Bose, and Dr. Guthe, especially the last named. Also the theory developed by Dr. Lee de Forest, and gives a description of two of the coherers used in wireless telegraphy. 4000 w. Sci Am Sup—Nov. 11, 1905. No. 73094.

Long Distance.

Long-Distance Telegraphy in Australia. T. Howard. An account of a trial of long-distance working over the Australian telegraph lines. 1000 w. Elec Rev, N Y—Nov. 25, 1905. No. 73471.

Space Telegraphy.

A Method of Testing Wireless Receivers. Greenleaf W. Pickard. Describes a method used by the writer. Diagram. 1000 w. Elec Wld & Engr—Nov. 25, 1905. No. 73469.

Earthed and Unearthed Radiators in Wireless Telegraphy. W. H. Eccles. A statement of the reasons and facts that have made the use of the earthed radiator almost universal and the use of one unearthed rather exceptional. 1800 w. Elect'n, Lond—Oct. 27, 1905. No. 73003 A.

The Strasburg Experiments upon Directed Wireless Telegraphy (Die Strassburger Versuche über Gerichtete Drahtlose Telegraphie). Dr. Ferdinand Braun. Describing the use of two sets of waves of very slight phase difference to enable the direction of the transmission to be controlled. 2000 w. Elektrotech u Polytech Rundschau—Nov. 1, 1905. No. 73362 D.

Telephony.

The Kellogg Common-Battery Telephone System. W. S. Henry. Illustrated description of this system as installed in Philadelphia. 1000 w. Am Elect'n—Nov., 1905. No. 73057.

The Use of the Telephone in Army and Navy Manœuvres. Col. B. K. Roberts. An account of the communications used during the recent Army and Navy exercises, to keep the officers informed as to the movements and approach of the Navy in its attack on the forts which defended the City of Washington. 1200 w. Elec Wld & Engr—Nov. 4, 1905. No. 73073.

Voice Overtones, or Harmonics, as Affecting Long-Distance Telephone Transmission. D. MacL. Therrell. Describes an apparatus and experiments for improving articulation. 4500 w. Elec Wld & Engr—Nov. 11, 1905. No. 73202.

DISTRIBUTION.

Controllers.

Magnetic Switch Controllers on Electrically Operated Automatic Ore Unloaders at Lorain, O. R. I. Wright. Gives a brief description of the control equipment, with illustrations of some typical elements of the equipment. The unloaders are of the Hulett type. 1200 w. Eng News—Nov. 9, 1905. No. 73081.

Earthing.

Tests for Earthing (Erdungsprüfer). Dr. M. Corsepius. Describing apparatus and methods for testing the completeness of earthing connections for machinery, lightning arresters, and other electrical appliances. 1800 w. Elektrotech Zeitschr—Oct. 19, 1905. No. 73349 B.

Fuses.

Zinc and Aluminium Fuses. Alfred Schwartz and W. H. N. James. An experimental examination of zinc and aluminium as materials for fusible cut-outs. 1200 w. Elec Rev, Lond—Nov. 17, 1905. Serial. 1st part. No. 73457 A.

Hamburg.

The Electric Distribution System of the City of Hamburg (Le Reseau de Distribution Electrique de la Ville de Hambourg). With plan of the city and plan and sections of the main generating station. 1500 w. 1 plate. Génie Civil—Oct. 21, 1905. No. 73311 D.

Hospital.

Electricity in the London Hospital. An illustrated description of the electric light and power installation, comprising about 6,000 lights and 100 motors. 5000 w. Elec Rev, Lond—Nov. 10, 1905. No. 73282 A.

Power Distribution.

Distribution of Electrical Energy. John Francis Cleverton Snell. Historical review of progress, and a discussion of the prospects of a wider commercial use of electrical energy. Discussion. Ills. 38000 w. (No. 3522.) Inst of Civ Engrs. No. 73152 N.

Electricity and Sewage Disposal. Illustrated description of the high tension power distribution scheme of the Birmingham Tame and Rea District Drainage Board to pump sewage to a higher level. It is also used to drive motors at various places, lighting, etc. 2300 w. Elec Engr, Lond—Nov. 17, 1905. No. 73455 A.

The Distribution of Electricity in Mines. Deals with the types of cable that should be used in the various situations and the most satisfactory methods of installing them. 1800 w. Elec Engr, Lond—Oct. 27, 1905. Serial. 1st part. No. 73001 A.

Transformers.

Switching System for the Reduction of Losses in Single and Polyphase Transformers when Operating Unloaded (Schaltungsanordnungen zur Vermeidung bezw. Verringerung der Leerlaufsarbeit bei Ein und Mehrphasen-Wechselstromtransformatoren). J. Schmidt. Describing hand operated and automatic switches for the cutting out of transformers. Two articles. 7500 w. Zeitschr f Elektrotechnik—Oct. 22, 29, 1905. No. 73356 each D.

The Multiple Operation of Transformers. R. T. MacKeen. Discusses the principles involved in the multiple operation of transformers, thus showing how to accomplish the best results. 2000 w. Can Elec News—Nov., 1905. No. 73207.

Warehouse.

The Technical Arrangement of the Oberpolliger Warehouse in Munich (Die Technischen Einrichtungen des Kaufhauses Oberpollinger in München). Julius Weil. Details of the sub-station converters, illumination, elevator service, etc., of a department store in Munich. Nernst lamps are extensively used. 4500 w. Elektrotech Zeitschr—Oct. 26, 1905. No. 73350 B.

Wiring.

Lead-Covered Wiring. John D. MacKenzie. Presents the advantages and disadvantages of this system, showing how some of the disadvantages may be minimized. 2000 w. Elec Rev, Lond—Nov. 10, 1905. No. 73281 A.

ELECTRO-CHEMISTRY.

Accumulators.

Accumulators without Lead Plates (Ueber Nichtbleiakkumulatoren). Dr. Karl Elbs. A discussion of the chemical reactions in storage batteries of the Edison and Jungner type, using an alkaline electrolyte and plates of other metals than lead. 1000 w. Zeitschr f Elektrochemie—Oct. 27, 1905. No 73360 G.

Accumulator without Lead Plates (Ueber Nichtbleiakkumulatoren). Dr. Gräfenberg. Discussing the operative conditions of the nickel-iron battery, giving curves, showing the discharging pressures. 1500 w. Zeitschr f Elektrochemie—Oct. 27, 1905. No. 73361 G.

Electric Storage Battery Engineering. J. Lester Woodbridge. Gives the points of difference between a dynamo and a storage battery, and discusses the character of the work the storage battery is best fitted to perform; also the characteristics of the storage battery and its auxiliary apparatus, its care, &c. 4500 w. Cassier's Mag—Nov., 1905. No. 72991 B.

Electric Furnaces.

An Electrical Steel-Furnace. Gustave Gin. Abstract of a paper read at meeting of the Am. Elec-Chem. Soc. Gives plan and sections of furnace, with description. 1000 w. Eng & Min Jour—Nov. 11, 1905. No. 73106.

Electric Furnaces. J. H. Stansbie. Abstract of a paper read before the Birmingham (Eng.) Electric Club. Brief illustrated descriptions of some simple forms of electric furnaces which can be readily fitted up for experimental purposes. 1400 w. Elec Engr, Lond—Nov. 10, 1905. No. 73279 A.

The Gin Electric Furnaces (Fours Electriques Gustave Gin). G. Dary. Illustrated description of the electric furnaces for refining steel, and for producing vanadium and its alloys, as exhibited at Liége. 2500 w. L'Electricien—Nov. 11, 1905. No. 73364 B.

The Ruthenburg and Acheson Furnaces. F. A. J. FitzGerald. Describes the working and explains the theory of these furnaces. 2000 w. Elec-Chem & Met Ind—Nov., 1905. No. 73070 C.

Electrolysis.

Alternate-Current Electrolysis as Shown by Oscillograph Records. W. R. Cooper. Read before the Faraday Soc. Reviews briefly recent views on this subject, and gives a report of experimental investigations, giving records obtained by a double oscillograph. 1800 w. Elec Engr, Lond—Nov. 3, 1905. No. 73127 A.

Alternating-Current Electrolysis? S. M. Kintner. Illustrated description of a test made under as nearly service conditions as possible, showing the action to be very slight. 1000 w. Elec Jour—Nov., 1905. No. 73407.

Electrolysis with Alternating Currents (Elektrolyse mit Wechselstrom). Dr. Max Le Blanc. Discussing especially the action of alternating currents upon complex solutions. 2000 w. Zeitschr f Elektrochemie—Oct. 27, 1905. No. 73358 G.

The Electrolysis of Water. Joseph W. Richards. Divides the subject into its experimental, its theoretical, and its applied phases, treating each in detail. Ills. 5000 w. Jour Fr Inst—Nov., 1905. No. 73098 D.

ELECTRO-PHYSICS.

Atmospheric Electricity.

Telluric Currents. Reviews an article by M. Guarini to the Belgian Astronomical Society upon telluric currents, their origin, direction, their disadvantages and their possible utilization. 2400 w. Sci Am Sup—Nov. 18, 1905. No. 73206.

Hysteresis.

Comparative Investigations upon Linear and Rotary Magnetic Hysteresis (Vergleichende Untersuchungen über Lineare und Drehende Magnetische Hysteresis). Dr. W. Wecken. A review of previous work, with data and results of the author's investigations on steel and on wrought and cast iron. 4500 w. Zeitschr f Elektrotechnik—Nov. 5, 1905. No. 73357 B.

Radioactivity.

Induced Radioactivity Excited in Air at the Foot of Waterfalls. J. C. McLennan. Read before the Am. Phys. Soc. An account of experimental investigations made of Niagara Falls, describing apparatus, experiments, &c. 3800 w. Sci Am Sup—Nov. 4, 1905. No. 72970.

Waves.

Wave Shapes in Three-Phase Transformers. R. C. Clinker. A study of the wave distortion produced in star-connected three-phase transformers, as shown by use of the Hospitalier ondograph. Editorial. 2000 w. Elect'n, Lond—Nov. 10, 1905. No. 73283 A.

GENERATING STATIONS.

Accumulators.

See Electrical Engineering, Electrochemistry.

Coal Handling.

See Mechanical Engineering, Power and Transmission.

Dynamos.

How to Build a Small Alternating-Current Dynamo Without Castings. Nevil Monroe Hopkins. Illustrates and describes a machine which produces a single-phase alternating current of 110-volts pressure, and is built without patterns or castings. 5000 w. Sci Am Sup—Nov. 11, 1905. No. 73095.

Efficiency.

The Efficiency of Electrical Power Generating Stations. H. M. Hobart. A study of the net annual efficiency of electric supply stations. Also editorial. 3000 w. Elec Wld & Engr—Nov. 25, 1905. No. 73466.

Hydroelectric.

Hydroelectric Plant on the Spring River, Kansas. Illustrated description of an interesting plant supplying electric power to the lead and zinc fields of Missouri. 3500 w. Elec Rev, N Y—Nov. 18, 1905. No. 73257.

Les Clées-Yverdon Hydraulic Plant. C. L. Durant. An illustrated description of a system furnishing power for numerous applications of electric motors and in small industries, as well as for large shops and for lighting. 3500 w. Elec Rev, N Y—Nov. 25, 1905. No. 73470.

Niagara Power in the Gorge. An illustrated historical review of the development of power in the gorge, dating back to 1853. 3500 w. Elec Wld & Engr—Nov. 18, 1905. Serial. 1st part. No. 73244.

The Charmey Power Station (Usine de Charmey). A Hostache. An illustrated description of the hydro-electric plant at Charmey, supplying the district about Bulle, near Fribourg, Switzerland. 2000 w. Bull Tech de la Suisse Rom—Oct. 25, 1905. No. 73367 D.

The Hydraulic Plant of the Chattanooga & Tennessee River Power Co. Brief illustrated description of a plant for utilizing 56,000 h. p. of the energy of the Tennessee River, at Hales Bar, Tenn. 1200 w. Eng Rec—Nov. 4, 1905. No. 73062.

The Hydro-Electric Plant of the Spring River Power Co. Illustrated description of a plant for furnishing power to the zinc mines near Joplin, Mo. The plant shows novel features of interest. 4000 w. Engr, U S A—Nov. 1, 1905. No. 72951 C.

The Kaiserwerke Hydro-Electric Station in the Tyrolese Oberland (Die Ueberland Zentrale Kaiserwerke). H. Manasse. A very fully illustrated account of the utilization of the discharge of Hinteroteiner Lake in the Tyrol, near Kufstein. Serial. Part I. 3500 w. Elektrotech Zeitschr—Nov. 9, 1905. No. 73355 B.

The Niagara Power Plant of the Electrical Development Company of Ontario. Begins an illustrated detailed description of the design and structures. 3000 w. Eng News—Nov. 9, 1905. Serial. 1st part. No. 73079.

The Washoe Power and Development Company's Plant on the Truckee River. Wyatt H. Allen. Illustrated detailed description of a plant for supplying the towns of Reno and Sparka, Nevada, with electric power and the final union of four companies, forming the "Union Light & Water Co." 4500 w. Jour of Elec—Nov., 1905. No. 73067 C.

Instruction.

Instruction of Men Operating Interconnected High and Low-Tension Systems, with Reference to Safety of Employees, Reliability of Service, and Resumption of Same After Partial or Total Interruption. W. F. Wells. Abstract of a paper at meeting of the Assn. of Edison Ill. Cos. 2800 w. Elec Rev, N Y—Nov. 18, 1905. No. 73256.

Isolated Plant.

Power and Lighting Equipment of a Modern Hotel. Illustrates and describes the engineering features of the Gotham hotel, at Fifth Ave. and Fifty-fifth St., New York City. 2000 w. Am Elect'n—Nov., 1905. No. 73054.

Lackawanna Plant.

The Power System of the Lackawanna R. R. in Luzerne Co., Pa. H. M. Warren. Deals with the preliminary estimates, plans and details of the plant under construction in the Nanticoke district, near Scranton, with its substations and transmission lines. 3800 w. Eng Rec—Nov. 4, 1905. No. 73059.

The Power Plant for the New Wanamaker Store, Philadelphia. Illustrated description of a plant for a twelve-story department store, supplying electric power for lighting and motors, steam, compressed air, and water. It is located a block distant. 4500 w. Eng Rec—Oct. 28, 1905. No. 72905.

Testing.

See Electrical Engineering, Measurement.

Three-Phase.

Three-Phase Generating Set (Groupe Electrogène Triphasé). J. A. Montpellier. Illustrated description of a 600 horse power Rateau steam turbine connected to 400 kw. alternator by Sautter, Harlé & Co., exhibited at Liége. 2000 w. L'Electricien—Oct. 28, 1905. No. 73363 B.

LIGHTING.

Car Lighting.

Some Wiring Diagrams for Car Lighting. Cole Gough. Diagrams and descriptions of various wiring schemes. 500 w. St Ry Jour—Nov. 2, 1905. No. 73027 C.

Hotel Illumination.

The Illumination of the Hotel Astor, New York City. E. Leavenworth Elliott. An illustrated article describing some of the changes made which has made this one of the most successfully lighted of modern buildings of this class. 2500 w. Cent. Sta—Nov., 1905. No. 73110.

Photometry.

See Electrical Engineering, Measurement.

Reflector.

The Diffusing Reflector. E. L. Zalinski. Information, based on measurements, made chiefly at the Electrical Testing Laboratories, in regard to the use of a different coating in connection with a prismed reflector, showing that the more important gain is the better distribution obtained. 2500 w. Elec Rev, N Y—Nov. 4, 1905. No. 73023.

Tantalum.

Tantalum and the Tantalum Electric Lamp (Das Tantal und die Tantallampe). Dr. Werner von Bolton. Describing the properties of metallic tantalum, with a brief description of the Siemens & Halske incandescent lamp with tantalum filament. 1500 w. Zeitschr f Elektrochemie—Oct. 27, 1905. No. 73359 G.

Theatre Illumination.

Electric Equipment of a Buffalo Theatre. Describing the arrangement of footlights and border lights dimmers, and switchboard for an equipment of more than 5,000 lamps; using a two-wire system. 1000 w. Elec Wld & Engr—Nov. 4, 1905. No. 73074.

MEASUREMENT.

Magnetization.

Measurement of the Specific Magnetization of Diamagnetic on Slightly Magnetic Bodies. Emile Guarini. Brief description of an apparatus designed by M. P. Curie and M. C. Cheneveau. 1000 w. Sci Am Sup—Nov. 11, 1905. No. 73096.

Meters.

Meters for Continuous Current, Single Phase, and Polyphase Currents, of the Aron Works at Charlottenburg (Umschaltzähler für Gleichstrom, Ein- und Mehrphasigen Wechselstrom der Elektrizitätszählerfabrik H. Aron in Charlottenburg). A report of tests made by the Reichsanstalt. 1000 w. Elektrotech Zeitschr—Oct. 19, 1905. No. 73348 B.

Photometry.

Reflectors, Shades and Globes. J. R. Cravath and V. R. Lansingh. A report of tests which give information on the photometric performance of common types. Ills. 2000 w. Elec Wld & Engr—Nov. 25, 1905. Serial. 1st part. No. 73467.

Some Tests on Lamp Globes. Maurice Solomon. A discussion of results obtained in the course of some experiments on the mean spherical candle-power and distribution of light with Nernst lamps. Also editorial. 3300 w. Elect'n, Lond—Nov. 3, 1905. No. 73129 A.

Standards.

The Regulations, Standards, and Specifications of the German Electrotechnical Association (Die Vorschriften, Normalien, und Leitsätze des Verbandes Deutscher Elektrotechniker). G. Dettmar. A general description, by the secretary of the association, of the electrical standards and working regulations relating to wiring and installation of machinery. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 21, 1905. No. 73302 D.

Testing.

A Small Motor Testing Equipment. Roy T. Wells. Describes an outfit for factory testing of small electric machines. 1000 w. Elec Wld & Engr—Nov. 25, 1905. No. 73468.

Commercial Testing of Electrical Machinery. The "Pump Back" Method. H. B. Foote. Describes the method of testing sets of machines by what is known as the "pump back" or "loss supply" method. Diagrams. 1000 w. Sib Jour of Engng—Oct., 1905. No. 73488 C.

MOTORS.

Classification.

Electric Motors and Their Applications. W. Edgar Reed. Gives a classification according to their speed-torque characteristics, and a statement regarding their other important operating characteristics, which are useful in making applications. Discussion. Ills. 6400 w. Pro Engrs' Soc of W Penn—Oct., 1905. No. 72980 D.

Induction Motors.

Notes on Alternate-Current Induction Motors. T. Harding Churton. Compares the performance and characteristics of motors provided with short-circuit and with wound rotors respectively; the performances of such motors on single-phase and polyphase circuits; and indicates the effect of frequency of alternations on the working of such motors. 4300 w. Elec Engr, Lond—Oct. 27, 1905. No. 73002 A.

Polyphase Motors.

The Application of Condensers in the Operation of Polyphase Motors (Anwendung der Kondensatoren bei Dauerndem Betrieb von Drehstrommotoren). J. Dalemont. Describing a method of operating three-phase motors from a single-phase main. 3000 w. Elektrotech Zeitschr—Nov. 2, 1905. No. 73354 B.

Testing.

See Electrical Engineering, Measurement.

TRANSMISSION.

Lightning Arresters.

Note on Lightning-Arresters on Italian High-Tension Transmission Lines. Philip Torchis. A report of observations made by the writer and reporting the best practice of to-day for the protection of Italian transmission lines. 800 w. Am Inst of Elec Engrs—Oct., 1905. No. 72925 D.

Performance of Lightning-Arresters on Transmission Lines. N. J. Neall. Describes a method of obtaining, by means of test-papers, records of the operation of lightning-arresters in service; gives some results obtained by the use of this method. Ills. 3500 w. Pro Am Inst of Elec Engrs—Nov., 1905. No. 73485 D.

Shaw's Lightning Arrester. Report of the Committee on Science and the Arts, on the invention of Henry M. Shaw. Ills. 900 w. Jour Fr Inst—Nov., 1905. No. 73097 D.

Some Experiences with Lightning Protective Apparatus. Julien C. Smith. Deals with experiences with lightning protective apparatus which the operating department of the Shawinigan Water & Power Co. has had during the years 1903, 1904 and 1905. Ills. 2000 w. Am Inst of Elec Engrs—Oct., 1905. No. 72924 D.

INDUSTRIAL ECONOMY

Coal Trade.

Problems of the Expansion of the American Coal Trade. F. E. Saward. A review of recent statistics, showing the enormous growth of the coal trade of the United States, both domestic and export. 2500 w. Engineering Magazine—Dec., 1905. No. 73376 B.

Exposition.

Mechanical and Technical Notes on the Liége Exposition (Maschen-technische Reisenotizen von der Lütticher Weltausstellung). Julius Divis. A general descriptive account of the mechanical exhibits, with professional comments. Serial. Part I. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 21, 1905. No. 73344 D.

Inspection.

The Position of the Constructing Engineer, and His Duties in Relation to Inspection and the Enforcement of Contracts. Albert J. Himes. 7000 w. Pro Am Soc of Civ Engrs—Nov., 1905. No. 73438 E.

Invention.

American Inventors in the German Patent Office. An official statement from Pres. Hauss, of the Imperial Patent Office, dealing with the treatment of American inventors as patentees in Germany. 1500 w. Elec Wld & Engr—Nov. 11, 1905. No. 73201.

Iron Industry.

The German Iron Industry in Competition for the Markets of the World (Die Deutsche Eisenindustrie und ihren Kampf um den Weltmarkt). Dr. Alexander Tille. A review of the influence of protection and free trade upon the export iron business of Germany. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 21, 1905. No. 73303 D.

The Iron and Steel Industry. A review of the production, comparing the principal iron producing countries. 3000 w. Engng—Nov. 10, 1905. No. 73290 A.

Labor.

Obstructionism, or a New Form of Strike on the Italian Railways. Explains this form of strike, relating the causes that led to it, describing how it became developed, the results, and measures taken against it. 3500 w. Bul Int Ry Cong—Oct., 1905. No. 73405 F.

The Incorporation of Labor Unions. Howard R. Bayne. Discusses the incorporation and does not consider that it should be made compulsory. 1500 w. R R Gaz—Vol. XXXIX., No. 20. No. 73228.

The Realization of Ideals in Industrial Engineering. H. F. J. Porter. A discussion of the effect of the human element upon the efficiency and working organizations in office and shop. 5500 w. Trans Am Soc of Mech Engrs (No. 082)—Dec., 1905. No. 73440.

Patents.

The Patent Law Situation. Ludwig Gutmann. A discussion on the present status of patents, with editorial comment. 3500 w. Elec Wld & Engr—Nov. 18, 1905. No. 73246.

Philippine Islands.

Labor Conditions in the Philippine Islands. J. W. Beardsley. Shows briefly some of the essential conditions surrounding the labor problem in the Philippines. 9500 w. Eng News—Nov. 23, 1905. No. 73421.

Sanitary Conditions as Affecting Contracts for Works, in the Philippine Islands. Maj. E. C. Carter. An authoritative report of present conditions. 2000 w. Eng News—Nov. 23, 1905. No. 73422.

Tabulating.

Tabulating - Machine Cost - Accounting for Factories of Diversified Product. Morrell W. Gaines. An examination of mechanical methods of analysing and tabulating records. 4000 w. Engineering Magazine—Dec., 1905. No. 73375 B.

MARINE AND NAVAL ENGINEERING

Battleships.

A Comparison of Recent Battleships. H. G. Gillmor. A comparison from the point of view of the designer and builder of the latest battleships of Gt. Britain, France, United States, Germany, Italy, and Japan. 3000 w. (No. 6.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73188 C.

Bending Moments.

Longitudinal Bending Moments of Certain Lake Steamers. W. I. Babcock. Describes the very large ships recently put on the Lakes to meet new conditions, and the lengthening of the "Victory." Investigates the changes in the longitudinal bending moments in a seaway in this ship, caused by this increase in length, and compares them with the largest ships now in lake service. 13 plates. 2800 w. (No. 9.) Soc Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73191 D.

Boilers.

See Mechanical Engineering, Steam Engineering.

Bulkheads.

Notes on the Strength of Water-Tight Bulkheads for Battleships and Cruisers. Harold F. Norton. Explains the tests required by the Navy Department for battleships and cruisers, and gives curves, derived from formulæ, by use of which the required results may be immediately obtained. 2 plates. 3000 w. (No. 11.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73193 C.

Coaling Station.

The New Coaling Station at Narragansett Bay. Illustrated description of a new coaling station recently completed at Bradford, near Newport, and its operation. 3000 w. Eng Rec—Nov. 25, 1905. No. 73496.

Coast Lines.

Coastwise Steamship Lines of the United States. Illustrates and describes types of vessels belonging to the domestic marine and gives information relating to the service. Also information in regard to the domestic trade. 4000 w. Naut Gaz—Nov. 2, 1905. No. 73040.

Cruisers.

The Cruiser. Com. William Hovgaard. Gives a brief historical review with a view to studying the relation between the development and the causes which have produced and governed it, and discusses the type and design of cruisers most suitable to existing conditions. 9500 w. 4 plates. (No. 5.) Soc Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73187 D.

Docks.

Floating Docks. Lyonel Edwin Clark. On types of floating docks, their advantages and capabilities, showing them to be thoroughly reliable and having in some cases distinct advantages. Discussion and correspondence. Ills. 51500 w. (No. 3500.) Inst of Civ Engrs. No. 73153 N.

The Wooden Floating Dry Dock at Mobile. Illustrations, with brief description. 700 w. Marine Engng—Nov., 1905. No. 72915 C.

Ice Yacht.

How to Build an Ice Yacht. H. Percy Ashley. Illustrates and describes how to build for the 300-sq. ft. class, which has been found most practicable. The two types of solid backbone construction most in use are shown. 2000 w. Rudder—Nov., 1905. No. 73016 C.

Lighthouse.

Beachy Head New Lighthouse. Albert Havelock Case. Illustrated detailed description of this structure and its equipment. 5300 w. Ills. (No. 3461.) Inst of Civ Engrs. No. 73176 N.

Liner.

The Twin-Screw Liner "Amerika." Illustrations, with brief description of this new Hamburg-American steamship. 1500 w. Sci Am—Nov. 4, 1905. No. 72968.

Liverpool.

Liverpool and Her Rival Ports. From the presidential address of T. Reney Smith, before the Liverpool Engng. Soc. Discusses improvements whereby the city trade and progress may be advanced, especially questions connected with the shipping facilities. 2000 w. Engr, Lond—Nov. 10, 1905. No. 73297 A.

Machinery.

Useful Data of Scotch Marine Engineering Practice. H. Wilkes. Gives tables and diagrams giving figures based upon engines, boilers, and accessories actually constructed by Scotch and English marine-engine builders. 1000 w. Marine Engng—Nov., 1905. No. 72913 C.

Mercantile Marine.

The Merchant Marine. George W. Dickie. Address, at Portland, before the Trans-Mississippi Commercial Congress. Also editorial. Discusses the difficulties with which American shipbuilders must contend, and the shipping interests of the United States. 6000 w. Marine Engng—Nov., 1905. No. 72912 C.

Motor Boats.

A Six-Cylinder 400-Horse-Power Racing Gasoline Power Boat. Illustrates and describes a racing boat built by the Brooke Motor Co. of Gt. Britain. 900 w. Sci Am—Nov. 11, 1905. No. 73092.

Internal-Combustion Motors for Marine Service (Der Gasmotor im Dienste der Schiffahrt). C. Stein. A fully illustrated account of recent liquid-fuel motors and their accompanying mechanism for boat propulsion. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—Oct. 28, Nov. 4, 1905. No. 73304 each D.

Problems in Connection with High-Speed Launches. Clinton H. Crane. Discusses points in design of boats driven by gasolene engines, especially the form of hull. 6 plates. 1500 w. (No. 15.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73197 C.

Progressive Speed Trials of the Gasolene Launch Ludo. George Crouse Cook. Gives particulars and data of speed and power obtained on a well designed launch. 1600 w. 4 plates. (No. 16.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73198 C.

Recent Motor Boats with Internal-Combustion Engines (Neuere Motorboote mit Verbrennungskraftmaschinen). W. Kammerer. Describing recent motor boats in England, France, and Germany. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 11, 1905. No. 73323 D.

The Sea-Going Motor Launch "Iris." Dimensions and illustrated description of the vessel and its equipment. 1500 w. Engng—Nov. 3, 1905. No. 73133 A.

Naval Battery.

The Ultima—A Globuloid Naval Battery. Anson Phelps Stokes. Describes this proposed new naval battery, comparing with an earlier model, and giving report of experiments with a model in the Government Model Basin. 13 plates. 3000 w. (No. 7.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73189 C.

Naval Station.

See Civil Engineering, Construction.

Ports.

Note on the Passage of Vessels in a Tidal River of Great Length. H. Crahay de Franchimont. Considers conditions needing study in planning the improvement of the depth of a navigable channel, and the preparation of route-charts. 1100 w. (No. 3579.) Inst of Civ Engrs. No. 73160 N.

The Ports of Antwerp and London. A comparison of the rival attractions of these ports, based on information from three recent reports. 1800 w. Engr, Lond—Oct. 27, 1905. No. 73010 A.

Propellers.

Experience in the Design of Screw Propellers. Horace See. Read before the Milan meeting of the International Navigation Congress. A discussion of points in propeller design, giving the more desirable formations, and information of tests and conclusions. 1200 w. Eng News Nov. 2, 1905. No. 72963.

Experimental Researches on the Performance of Screw Propellers. W. F. Durand. A report of investigations carried on in the canal of the hydraulic laboratory of Cornell University, covering in effect the performance of 49 model propellers. 36 plates. 4800 w. (No. 3.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73185 E.

Propulsion.

Some Problems in Ferry-Boat Propulsion. Col. E. A. Stevens. A report of tests made of model wheels of the Scranton, Scandinavia and Edgewater, in the United States experimental basin. 4 plates. (No. 1.) 700 w. Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73183 C.

Some Results of Tests of Model Propellers. A. V. Curtis, and L. F. Hewins. Presents results of experiments in two, four, and six-bladed propellers, at the U. S. Ex. Model Basin. 15 plates. 2000 k. (No. 4.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73186 D.

Slipway.

Slipway at Tucacas, Venezuela. Arthur Drew Thomas. Short description, with illustration, of the construction of a slipway on the northern coast of South America. 1000 w. (No. 3511.) Inst of Civ Engrs. No. 73162 N.

Spare Fittings.

Spare Gear for Steamers. F. J. Kean. Gives lists of spare gear customary at the present time for an ocean-going steamer to carry, discussing the necessity of carrying certain fittings. 1500 w. Prac Engr —Nov. 10, 1905. Serial. 1st part. No. 73277 A.

Speed Trials.

Methods of Conducting Speed Trials. J. J. Woodward. Remarks on contract trial requirements, and a description of the methods of concluding speed trials under present conditions. Tables and plates. 20000 w. (No. 18.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73236 G.

Submarines.

Notes on Submarine Boats (Ueber Unterseeboote). C. Stainer. A general review of the development of submarine navigation, and a discussion of the present state of the art. 5000 w. Stahl u Eisen—Nov. 1, 1905. No. 73368 D.

Turbines.

Marine Applications of the Curtis Steam Turbine. Charles G. Curtis. Information concerning vessels propelled by steam turbines of this type and the results obtained. 1500 w. (No. 12.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73194 C.

Marine Steam Turbine Development and Design. E. M. Speakman. Reviews the rapid development that has taken place in Great Britain, compares turbines with reciprocating engines, and discusses their design. 30 plates. 8400 w. (No. 13.) Soc of Nav Archts & Marine Engrs —Nov. 16, 1905. No. 73195 D.

The Determination of the Principal Dimensions of the Steam Turbine with Special Reference to Marine Work. E. M. Speakman. Read before the Inst. of Engrs. & Shipbuilders in Scotland. Discusses the design of turbine installations, the necessary calculation for propeller dimensions, &c. Ills. 3800 w. Engr, Lond—Nov. 17, 1905. Serial. 1st part. No. 73465 A.

The Turbine-Driven Steamer Viking. L. Ramakers. Illustrated detailed description. 1100 w. Marine Engng—Nov., 1903. No. 72911 C.

See also Mechanical Engineering, Steam Engineering.

Ventilation.

Experiments with Ventilating Fans and Pipes. D. W. Taylor. Describes experiments undertaken to determine the capacities and efficiencies of fans used for ventilation on U. S. naval vessels, and to obtain information for the design of systems of ventilation piping. 40 plates. (No. 2.) 11000 w. Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73184 F.

Warship Design.

A Note from Japan. George W. Dickie. A note from a Japanese naval constructor is quoted, and the points named as of importance to gain a victory are discussed. 2 plates. 3000 w. (No. 8.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73190 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air-Cooling.

Practical Experiences with Air-Cooled Cars. Harry B. Haines. Gives some personal experiences with air-cooled machines on varying road conditions. 2800 w. Automobile—Nov. 2, 1905. Serial. 1st part. No. 73014.

Arrol-Johnston.

The Arrol-Johnston Motor Car. An illustrated detailed description ot the car which won the Tourist Trophy Race in the Isle of Man. 4000 w. Engng—Nov. 10, 1905. Serial. 1st part. No. 73289 A.

Bianchi.

The Bianchi Petrol Car. Illustrates and describes these Italian cars of the chain-driven type, with four-cylinder engines and four-speed gear boxes. 700 w. Auto Jour—Nov. 18, 1905. No. 73477 A.

Braking.

Use of the Motor for Braking. Rene M. Petard. Explains the advantages to be gained by using the motor of a gasolene automobile as a brake, and the most advantageous method of obtaining a braking effect. 1800 w. Automobile—Nov. 9, 1905. No. 73100.

Brotherhood.

The "Brotherhood" Petrol Cars. Illustrated description of novel features introduced in the latest model. 700 w. Auto Jour—Nov. 18, 1905. No. 73478 A.

Economy Test.

An Automobile Economy Test. An illustrated account of the recent test carried out by the N. Y. Motor Club, to demonstrate the efficiency of the American gasoline automobile. 1000 w. Sci Am—Nov. 18, 1905. No. 73204.

Fire Appliances.

Motor Fire-Appliances for Vienna. Illustrations, with information of these self-propelled appliances. 1000 w. Engng—Nov. 10, 1905. No. 73287 A.

Garage.

Model Garage in Harlem. Illustrates and describes a new storage station in upper Manhattan Island. 1000 w. Automobile—Nov. 23, 1905. No. 73428.

Iris.

Details of the "Iris" Touring Motor-Car. Many illustrations and descriptive notes. 2700 w. Engng—Nov. 17, 1905. No. 73483 A.

The "Iris" Cars. An illustrated article describing the leading features of cars recently redesigned. 1500 w. Motor Car Jour—Nov. 11, 1905. No. 73269 A.

The 1906 Legros and Knowles "Iris" Cars. Illustrated detailed description of two touring models recently brought out. 1500 w. Auto Jour—Nov. 11, 1905. Serial. 1st part. No. 73273 A.

Kerosene.

Car Using Kerosene Oil as Fuel. Illustrates and describes a carbureter that will enable an ordinary explosion motor to run successfully on either gasoline or kerosene; and an air-cushion, which makes solid rubber tires as easy riding as pneumatic tires. 2200 w. Automobile—Nov. 9, 1905. No. 73099.

Lubricator.

The Albion Mechanical Lubricator. Calls attention to the tendency toward over-lubrication and the disagreeable results, and gives an illustrated description of a device designed to overcome these features and yet ensure efficient lubrication at all times. 1000 w. Motor-Car Jour—Nov. 11, 1905. No. 73270 A.

The Albion Mechanical Lubricator. Illustrates and describes the ingenious lubricator fitted to all Albion cars, invented by T. Blackwood Murray. 600 w. Autocar—Oct. 28, 1905. No. 73000 A.

Morgan.

A New All-British Car. An illustrated description of a 24 h. p. Morgan car. 1800 w. Autocar—Nov. 11, 1905. No. 73272 A.

Olympia.

Some Leading Cars at Olympia. Illustrates and describes new models of various makes exhibited. 1500 w. Auto Jour —Nov. 18, 1905. Serial. 1st part. No. 73476 A.

Peerless.

New Peerless Designs for 1906. Two new cars are to be placed on the market by this Cleveland, O., company, one of 30 h. p., the other 45 h. p. The 30 h. p. car is illustrated and described. 2000 w. Automobile—Nov. 23, 1905. No. 73429.

Pneumatic Hub.

The Middleton Pneumatic Hub. Illustrates and describes an invention for rendering solid-tired wheels more resilient. A pneumatic cushion surrounds the hub in much the same way that a pneumatic tire surrounds the felloe. 900 w. Auto Jour—Nov. 18, 1905. No. 73479 A.

Rolls-Royce.

Multi-Cylinder Rolls-Royce Cars—Two 8-Cylinder Models. Illustrated description of a landaulet, and a touring car having features of interest. 1500 w. Auto Jour—Nov. 11, 1905. No. 73274 A.

Serpollet.

The Serpollet Steam Vehicles. Illustrated description of recently introduced features of these vehicles. 2200 w. Engr, Lond—Oct. 27, 1905. No. 73009 A.

Shock Absorber.

Pneumatic Shock Absorber for Vehicles (Amortisseur Pneumatique pour Voitures). H. Mamy. The Bernard & Patoureau device consists of an inflated cushion interposed between the spring and the body of the vehicle. 1000 w. Génie Civil—Oct. 28, 1905. No. 73315 D.

Side-Drive.

The 25-H. P. James and Browne Side-Drive Car. Gives an illustrated description of the design of a new side-drive car. 1200 w. Autocar—Nov. 18, 1905. No. 73480 A.

Speed Gearing.

The Lloyd Change-Speed Gear. Illustrated description of this gear and its operation. 1400 w. Autocar—Oct. 28, 1905. No. 72999 A.

Steering.

Klee's Tangential Steering Gear. Illustrates and describes an invention designed to overcome a slight inaccuracy in systems having their front wheels interconnected by one tie rod of invariable length. 600 w. Auto Jour—Nov. 11, 1905. No. 73275 A.

Sunbeam.

The Sunbeam Car for 1906. Illustrated description of a new design with a 16 H.-P. engine. The chains and brakes are arranged to operate continuously in oil baths. 2800 w. Autocar—Nov. 4, 1905. No. 73122 A.

Touring Cars.

Chadwick Touring Car, 1906 Model. Illustrations and detailed description of an interesting machine built in Philadelphia. 2700 w. Automobile—Nov. 2, 1905. No. 73015.

Tractor.

The Scott Gasoline-Motor-Propelled Agricultural Tractor. Illustrates and describes an interesting tractor and its ingenious attachments, shown at the show of the British Royal Agricultural Society. 1000 w. Sci Am Sup -Nov. 4, 1905. No. 72973.

COMBUSTION MOTORS.

Balancing.

The Balancing of Multi-Cylinder Petrol Engines. An investigation made to inquire into the conditions which give rise to vibration, and the possibility of considerably reducing it by arranging the mechanism of petrol engines in such a manner as to ensure complete balancing of the inertia forces. 2000 w. Engr, Lond—Nov. 17, 1905. No. 73462 A.

Gas Engines.

The Nuremberg Gas-Engine. Illustrates and describes the principal features of this gas-engine which has recently been built in very large sizes, and extensively adopted for running with blast-furnace gas, and other cheap gases. 900 w. Engng—Nov. 3, 1905. No. 73131 A.

The Various Methods of Governing Four-Cycle Gas Engines. Rodolphe Mathot. A comparison of the hit-or-miss method with those employing regulation of the charge. 3000 w. Engineering Magazine—Dec., 1905. No. 73374 B.

Gas Producers.

Gas Producers and Producer Gas. Dr. R. S. Moss. Describes the method of producing the gas, the composition of the coal used, &c., in the present number. 1800 w. Min Wld—Nov. 11, 1905. Serial. 1st part. No. 73118.

Recent Gas Producers (Neuere Kraftgaserzeuger). R. Schöttler. Illustrating and describing improved types of suction gas-producers for direct connection to gas engines. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 11, 1905. No. 73321 D.

Results of the Preliminary Producer

Gas Tests of the United States Geological Survey Coal Testing Plant at St. Louis. R. H. Fernald. An account of the preliminary work. Ills. 2500 w. Trans Am Soc of Mech Engrs (No. 080)—Dec., 1905. No. 73442 C.

Trials of Suction Gas-Producer Plants. Report on the trials under the auspices of the Highland and Agricultural Society of Scotland. 2500 w. Mech Engr—Nov. 11, 1905. No. 73278 A.

Gas Turbines.

The Problem of the Gas-Turbine. Dugald Clerk. Inaugural address to the Jun. Inst. of Engrs. A critical review of what has been written and attempted in this field, not favorable to expectations of future success. 4500 w. Jour of Gas Lgt—Nov. 7, 1905. No. 73271 A.

Petrol Motor.

140-Horse-Power Wolseley Petrol-Motor. Illustrated description of one of the largest petrol-motors yet constructed for industrial use. Built for the General Electric Co., U. S. A., for railway traction. 2400 w. Engng—Nov. 10, 1905. No. 73288 A.

Poppet Valves.

The Pressure Drop Through Poppet Valves. Charles Edward Lucke. A report of tests made to determine the relation between pressure drop through a poppet valve and the condition of flow, form of opening, &c., that give rise to the pressure drop observed. Ills. 2800 w. Trans Am Soc of Mech Engrs, No. 084—Dec., 1905. No. 73499 D.

HEATING AND COOLING.

Heating Surface.

Determination to Heating Surface. Review of a paper by J. Nelson Russell, before the Brit. Inst. of Heat. & Ven. Engrs., explaining the writer's method of determining the amount of heating surface needed in heating and ventilating work. 2200 w. Met Work—Nov. 11, 1905. No. 73066.

Hot Air.

A Notable Departure in Furnace Heating. Illustrated description of a system introducing round risers. 2200 w. Met Work—Nov. 4, 1905. No. 72982.

Incrustation.

Hot Water Supply by Indirect Heating. —A Remedy for Incrustation Difficulties. George Chasser. Read before the Brit. Inst. of Heat. & Vent. Engrs. Discusses difficulties due to hard water, and the remedy. Diagrams. 5000 w. Plumb & Dec—Nov., 1905. No. 73121 A.

Refrigeration.

Scale. Arthur Pennell. Cause of formation of scale in ice making and refrigerating plants and method of prevention or of minimizing losses from this cause. 1500 w. Ice & Refrig—Nov., 1905. No. 73046 C.

The Relation of the Central Station to the Motor-Driven Refrigerating Machine. G. W. Goddard. Abstract of a paper read at meeting of the Edison Ill. Cos. Explains the system of the present refrigeration compression machine, and its many applications, showing the advantages of motor-driving. 1600 w. Elec Rev, N Y—Nov. 11, 1905. No. 73112.

Schools.

Heating and Ventilating a medium-Sized School Building. Gives an illustrated description of the heating and ventilating system used in Public School 132, in the Bronx, New York City. 1000 w. Heat & Vent Mag—Nov., 1905. No. 73263.

The Progress of American Schools in Regard to Health Laws. J. D. Sutcliffe. Read at meeting of the Inst. of Heat. & Vent. Engrs., London. Discusses the heating, ventilation, sanitation and fire appliances from an English engineer's point of view. 3000 w. Heat & Vent Mag—Nov., 1905. No. 73265.

Steam Heating.

Sketch Details of Heating Installations. Frank G. McCann. Gives special sketch details prepared for use of New York City Board of Education. 1200 w. Heat & Vent Mag—Nov., 1905. No. 73262.

Steam Heating of Classrooms on a Recreation Pier in New York City. Illustrated description of an unusual installation made necessary by the need of temporary school accommodations. 2500 w. Met Work—Nov. 4, 1905. No. 72984.

Ventilation.

The Ventilation System in the Royal Uranium Color Works at St. Joachimsthal (Die Ventilationsanlage in der K. K. Uranfarbenfabrik zu St. Joachimsthal). F. Janda. Describing an arrangement of exhaust pipes and hoods over the tanks containing the alkaline solutions. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 4, 1905. No. 73345 D.

HYDRAULICS.

Centrifugal.

The Efficiency of Centrifugal Pumps (Die Kreisel und ihre Leistungen). H. Hagens. An appendix to a previous paper giving a mathematical examination of the tests previously recorded. 2000 w. Zeitschr d Ver Deutscher Ing—Oct. 28, 1905. No. 73305 D.

Flow.

The Discharge of Water Through Street Taps and House Service Pipes.

William Paul Gerhard. Gives double-page diagram with curves plotted by formulæ, and explanation of its use. 2500 w. Cassier's Mag—Nov., 1905. No. 72986 B.

The Gauging of Streams by Chemical Means. Charles Edmond Stromeyer. Describes the means by which the chemical method can be most successfully applied in practice. 3500 w. Ills. (No. 3514.) Inst of Civ Engrs. No. 73181 N.

The Resistance Offered to the Flow of Water in Pipes by Bends and Elbows. Connell William Long Alexander. Describes an experimental investigation of the nature and magnitude of the resistance offered by bends, knees, and elbows, to the flow of water through closed pipes. 5300 w. Ills. (Students' Paper No. 526.) Inst of Civ Engrs. No. 73178 N.

The Velocity of Water Flowing Down a Steep Slope. Ernest Prescot Hill. Gives investigations and the assumptions involved. 800 w. (No. 3520.) Inst of Civ Engrs. No. 73161 N.

Plumbing.

The Durham System of Plumbing. A serial, in three parts, illustrating and describing this system. 1300 w. Met Work —Nov. 4, 1905. Serial. 1st part. No. 72983.

Pumping Plant.

See Civil Engineering, Water Supply.

Pumps.

An Unusual Pump. Illustrated description of an installation for the water supply of Catlettsburg and Ashland, Ky., explaining the conditions it is adapted to meet. 1800 w. Eng Rec—Nov. 25, 1905. No. 73498.

Turbine Plants.

Preliminary Plans for Turbine Plants (Erster Entwurf von Turbinenanlagen). N. Baashuus. Discussing the simple calculations required to determine the general questions involved in the planning of a hydraulic turbine installation. 4000 w. Elektrotech Zeitschr—Oct. 18, 1905. No. 73347 B.

Valves.

The Slip of Discharge Valves. C. H. Benjamin. A report of experiments made to determine the effect of variations in the lift and stiffness of the spring on the discharge through the valves of a feed pump. 700 w. Engr, U S A—Nov. 15, 1905. No. 73259 C.

MACHINE WORKS AND FOUNDRIES.

Air Furnaces.

Operation of Air Furnaces. L. G. Blunt. Discusses the method of making up the bottom, of calculating the charge, of placing metal in furnace, flame regulation, and taking of the fracture tests. Ills. 1200 w. Foundry—Nov., 1905. No. 72917.

Boring Mill.

A Floor Plate Boring Mill at the Crocker-Wheeler Works. Illustrated detailed description of machinery used in the construction of heavy electrical apparatus. 2000 w. Mach, N Y—Nov., 1905. No. 72938 C.

Cartridge Cases.

The Manufacture of Cartridge-Cases for Quick-Firing Guns. Col. Leandro Cubillo, and Archibald P. Head. Illustrates and describes the new plant at the Royal Spanish Arsenal at Trubia, Spain, for the manufacture of brass cartridge-cases, stating the advantages of metal cases, and giving some of the mechanical properties which show brass to be best suited for this service. 9000 w. Inst of Mech Engrs—Oct. 20, 1905. No. 73006 D.

Castings.

Making a Clutch Coupling on the Molding Machine. George Buchanan. An illustrated description of the method employed. 700 w. Am Mach—Vol. 28. No. 45. No. 73078.

Making a Pattern and Mold for a Power Press. R. H. Palmer. Illustrates and describes inexpensive method of making a pattern when only one casting is required. 1800 w. Am Mach—Vol. 28. No. 46. No. 73213.

Standard Specifications for Gray Iron Castings. Gives the specifications adopted by the American Society for Testing Materials. Ills. 600 w. Ir Trds Rev—Nov. 2, 1905. No. 72976.

Chemistry.

Chemistry in Foundry Operation (Die Chemie im Giessereibetriebe). C. Henning. An address showing the value of applied chemistry in connection with daily foundry work. Serial. Part I. Stahl u Eisen—Nov. 1, 1905. No. 73371 D.

Cores.

Venting Difficult Cores. Walter J. May. Suggestions for making vents or gas passages in unusual shapes. Ills. 600 w. Prac Engr—Nov. 3, 1905. No. 73125 A.

Cranes.

See Mechanical Engineering, Power and Transmission.

Drills.

Six-Spindle Special Driller. Illustrated description of a machine built for drilling the spanner holes in small hardware and machine parts all at one operation. 600 w Am Mach—Vol. 28. No. 46. No. 73215.

Electrical Works.

The East Pilton Works of Messrs. Bruce Peebles & Co., Ltd. Illustrated description of the largest works for making electrical machinery in Scotland, at Edinburgh. 1800 w. Elec Rev, Lond—Nov. 17, 1905. Serial. 1st part. No. 73458 A.

Exposition.

See Industrial Economy.

Galvanizing.

The Galvanizing of Iron and Steel Surfaces. Sherard Cowper-Coles. Illustrates and describes the hot galvanizing process, and the electro or cold galvanizing process, giving related information. 4800 w. Ir & Coal Trds Rev—Nov. 10, 1905. No. 73427 A.

Grinder.

Mayer's Twist Drill Grinder. Illustrated description of a machine for automatically grinding twist drills recently devised by G. M. Meyer, of Germany. 1100 w. Mech Eng—Oct. 28, 1905. No. 72996 A.

Hooks.

The Theory of Hooks. Walter Rautenstrauch. Gives the theory recently developed by Mr. E. S. Andrews and Prof. Karl Pearson, and extracts from experiments conducted to prove it. Ills. 1500 w. Sib Jour of Engng—Oct., 1905. No. 73486 C.

Lathe.

The Lo-Swing Lathe. Illustrations, with description, of a novel lathe design, explaining its object. 1700 w. Am Mach—Vol. 28. No. 44. No. 72949.

Lathe Works.

Lang's Lathe Works at Johnstone, Scotland. J. William Chubb. Illustrated detailed description. 3200 w. Am Mach—Vol. 28. No. 44. No. 72948.

Machinery Foundations.

The Anthoni-Prache Foundation System for the Prevention of Noise and Vibrations (Fondations Isolantes Anthoni-Prache). Describing a system for absorbing vibrations by the interposition of sheets of rubber between machines and foundations. 4000 w. Mem Soc Ing Civ de France—Sept., 1905. No. 73335 G.

Machine Tools.

Machine Tools at the Liége Exposition (Die Weltausstellung in Lüttich, 1905. Die Werkzenmaschinen). G. Schlesinger. The first of a series of fully illustrated articles showing the machine tools from various countries exhibited at Liége. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 4, 1905. No. 73306 D.

Milling.

Milling Machine Fixtures. The present article considers the milling machine vise, which has a stationary and a movable jaw, against which are placed removable jaws, held in place by means of screws. Ills. 2000 w. Mach, N Y—Nov., 1905. Serial. 1st part. No. 72940 C.

Molding.

Molding a Large Gear Wheel. Samuel Groves. An illustrated detailed description of the Groves' Portable Gear Molding Machine and its operation. 3000 w. Can Engr—Nov., 1905. No. 73051.

Molding a Three Way Cock. H. J. McCaslin. Gives method used in molding a rather difficult casting. Ills. 500 w. Foundry—Nov., 1905. No. 72919.

Molding Machine Equipment. T. E. Vanderslice. Illustrates and describes special devices for use on molding machines, their use, etc. 3800 w. Am Mach—Vol. 28. No. 45. No. 73076.

Molding Machine Practice. F. W. Hall, in *The Patternmaker.* Shows a special casting mounted on different types of machines, and discusses the advantages and disadvantages of one type compared with the other. 2500 w. Foundry—Nov., 1905. No. 72920.

Object Lessons.

Fads and Fancies. W. E. Symons. A discussion of some object lessons in the mechanical department. General discussion. 10800 w. Pro W Ry Club—Oct. 17, 1905. No. 73410 C.

Patterns.

Metal Foundry Patterns. Walter J. May. Considers when it is worth while to make metal patterns, points of importance in making them, their advantages, cost, and related matters of interest. 3000 w. Sci Am Sup—Nov. 25, 1905. No. 73418.

Repairs.

Designing Machinery to Facilitate Repairs. Joseph Horner. An illustrated article offering suggestions in design that will facilitate the quick removal of the parts of a machine most subject to wear, and the substitution of new parts. 3500 w. Cassier's Mag—Nov., 1905. No. 72988 B.

Saw.

The Taylor-Newbold Saw. S. Newbold. Read before the Phila. Found. Assn. Illustrates and describes this tool and its operation. 2000 w. Foundry—Nov., 1905. No. 72918.

Shop Practice.

Machine Shop Practice. G. M. Campbell. Discusses chiefly the equipment of the shops, indicating how much can be done in the way of cheapening the output. Also discussion. 9000 w. Pro Engrs' Soc of W Penn—Nov., 1905. No. 73412 D.

Steel Tubes.

The Manufacture of Weldless Steel Tubes. John David Morgan. Describes the methods of manufacture as conducted at the present time. 5500 w. (Students' Paper No. 515.) Ills. Inst of Civ Engrs. No. 73175 N.

Upsetting.

Tube-Upsetting Machine (Röhrenstauchmaschine). Carl Wadas. Describing a hydraulic press for upsetting or thickening the walls of wrought tubing by longitudinal pressure. 1200 w. Stahl u Eisen—Nov. 1, 1905. No. 73370 D.

MATERIALS OF CONSTRUCTION.

Alloys.

Ferrovanadium. Dr. Ohly. Discusses properties of some alloys in iron and steel, especially the remarkable qualities of chrome-vanadium steel in regard to strength and ductility. 2500 w. Mines & Min—Nov., 1905. No. 73038 C.

Magnetic Alloys. V. Quittner. Translated from *Prometheus.* Information concerning recent studies of magnetic alloys and the results. 2000 w. Sci Am Sup—Nov. 4, 1905. No. 72971.

Heat Treatment.

The Heat Treatment of Steel in Large Masses (Wärmebehandlung von Stahl in Grossen Massen). O. Bauer. A comparison of the conditions existing in laboratory tests with those obtaining in actual practice, especially as regards mass and time. 2500 w. Stahl u Eisen—Nov. 1, 1905. No. 73369 D.

Stresses.

Simplified Methods for Rendering Neutral Layers Visible (Vereinfachtes Verfahren zur Sichtbarmachung der Neutralen Schichte). Otto Hönigsberg. An account of experiments upon glass beams with polarized light, supplementing those of the author published in March, 1904. 1200 w. Zeitschr d Oesterr Ing u Arch Verein—Oct. 20, 1905. No. 73327 D.

Testing.

The American Society for Testing Materials. Paul Kreutzpointner. An address on the work, value, and national economic aims and importance of this society. 4500 w. Pro Engrs' Soc of W Penn—Oct., 1905. No. 72981 D.

Tool Steels.

High-Speed Steel in the Factory. O. M. Becker. The fourth article deals with the design and operation of tools and machines for use with high-speed steel. 6000 w. Engineering Magazine—Dec., 1905. No. 73378 B.

The Practical Use and Economy of High-Speed Steel. J. M. Gledhill. Abstract of a paper read before the Glasgow & W. of Scotland Foremen Engrs. & Ironworkers Assn. Gives some comparative experiments with a view to ascertaining the saving in power absorbed with high-speed cutting. Illustrates some machines, and work accomplished. 2700 w. Ir & Coal Trds Rev—Nov. 17, 1905. No. 73461 A.

MEASUREMENT.

Air Flow.

On the Measurement of Air Flowing Into the Atmosphere Through Circular Orifices in Thin Plates and Under Small Differences of Pressure. R. J. Durley. Describes experiments made at McGill University. Ills. 5000 w. Trans Am Soc of Mech Engrs (No. 081)—Dec., 1905. No. 73441 D.

Dynamometer.

A New Swiss Dynamometer. Emile Guarini. Illustration, with description of a new type of geared dynamometer, having a capacity of 12 horse-power. 800 w. Am Mach—Vol. 28, No. 46. No. 73214.

Nozzles.

Experiments Upon the Flow of Gases in the Laval Type of Nozzle (Untersuchung der Gasströmung in der Laval Düse). Adolf Langrod. A study of experiments in cases in which the pressure in the most contracted portion is higher than the critical value. Two articles. 4000 w. Zeitschr d Oesterr Ing u Arch—Oct. 20, 27, 1905. No. 73328 each D.

Pyrometer.

The Fery Radiation Pyrometer. Illustrates and describes an instrument intended for the measurement of the temperature of furnaces of all kinds. 1500 w. Am Mach—Vol. 28. No. 46. No. 73217.

Slide Rule.

Short Cuts on the Slide Rule. Carl P. Nachod. Explains the use of the slide rule for calculations, showing its value. 900 w. Am Mach—Vol. 28. No. 46. No. 73216.

Spring-Balance.

The Corrections to be Applied to the Readings of a Spring-Balance When Used Horizontally or on a Slope. Alfred Ernest Young. Discusses the corrections needed. 800 w. (No. 3532.) Inst of Civ Engrs. No. 73159 N.

Straightedges.

How a Knife-edge Straightedge Was Made. F. N. Gardner. Describes some of the methods that led to success, and indicates "how not to do it." Ills. 2000 w. Mach, N Y—Nov., 1905. No. 72942 C.

Temperature.

Calculating Temperature Rises With a Slide Rule. Miles Walker. Describes a method which takes into account the changes of temperature coëfficient with temperature. 600 w. Elec Jour—Nov., 1905. No. 73408.

Torsion Meter.

An English Torsion Meter. C. Smith. Illustrates and describes an instrument for finding the torsion of revolving shafts, and thus ascertaining the horsepower developed. 1400 w. Engr, U S A—Nov. 1, 1905. No. 73953 C.

POWER AND TRANSMISSION.

Belts.

A Contact Roller for Belts (L'Enrouleur de Courroies). J. Teisset. A discussion of the advantages of auxiliary pulleys for increasing the arc of contact of belts with pulleys. 7000 w. Mem Soc Ing Civ de France—Sept., 1905. No. 73336 G.

Belts and Belt Driving (Ueber Riemen und Riementriebe). Fritz Krull. With tables of power transmitted, and illustrations of methods of driving. The construction and care of belts are discussed. Two articles. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 3, 10, 1905. No. 73331 each D.

Cableways.

Kotagudi Aerial Ropeway and Connecting Roads in North Travancore. Richard Fenwick Thorp. Describes the Construction of a ropeway, a tramway, and a cart road to improve transportation in a mountainous portion of India. Ills. 4200 w. (No. 3524.) Inst of Civ Engrs. No. 73170 N.

The Aerial Ropeway at the Rother Vale Collieries. Illustrated description of a ropeway to carry 2-ton loads, recently put in operation. 1500 w. Ir & Coal Trds Rev —Oct. 27, 1905. No. 73013 A.

Coal Handling.

Coal Handling and Storage. Charles H. Parker. Read before the Assn. of Edison Ill. Cos. An illustrated description of the apparatus installed at the South Boston Plant of the Edison Illuminating Company. 4500 w. Cent Sta—Nov., 1905. No. 73111.

Compressed Air.

A Central Compressed Air Power Plant for Heavy Railroad Construction. Lucius I. Wightman. Description, with illustrations, of the central station located near Safe Harbor, for carrying on extensive railway work on the low grade freight line of the Pennsylvania R. R. 3000 w. Eng Rec—Oct. 28, 1905. No. 72904.

Cranes.

A Fifty-Ton Electric Crane. Illustrated description of the mammoth electric crane for the new graving dock at Southampton. 900 w. Sci Am Sup—Nov. 25, 1905. No. 73416.

An Interesting 40-Ton Block-Setting Crane for Harbor Construction. Illustrated description of a crane with a radius of 115 feet, recently built in Great Britain for the construction of the harbor at Table Bay in South Africa. 900 w. Sci Am Sup—Nov. 4, 1905. No. 72972.

Electric Cranes. Claude William Hill. States the requirements where large quantities of material must be handled, and the advantages of electrical driving, discussing the worm-gear, bearings, motors and controllers, etc. Diagrams. 4800 w. (No. 3515.) Inst of Civ Engrs. No. 73179 N.

Electric Traveling Crane at the Liége Exposition (Elektrisch Betriebener Laufkran auf der Weltausstellung in Lüttich, 1905). Andreas Stamm. Illustrated description of 30-ton traveling crane of 79 feet span. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 11, 1905. No. 73324 D.

Locomotive Cranes as Labor Savers. Lewis Glasgow Howlett. Illustrates and describes some of these cranes and their operation, and the uses to which they have been applied. 2500 w. Cassier's Mag —Nov., 1905. No. 72987 B.

Elevator.

The Electric Elevator on the Burgenstock (L'Ascenseur Electrique du Burgenstock). P. Chignaterie. An illustrated description of the tower and lift giving access to the high cliffs on the banks of the lake of Lucerne, Switzerland. 1000 w. Génie Civil—Oct. 21, 1905. No. 73309 D.

Tests of Elevator Plant in the Trinity Building, New York City. Arthur J. Herschmann. A report of commercial tests made while the plant was in regular operation. Tables. Ills. 1500 w. Trans Am Soc of Mech Engrs (No. 079)—Dec., 1905. No. 73443 C.

Fans.

Centrifugal Fans. Thomas H. Johnson. Data on the performance of fans and a discussion of the influence of the structure or design, reporting tests. General discussion. Ills. 9500 w. Pro Engrs' Soc of W Penn—Nov., 1905. No. 73411 D.

Fly Wheels.

Exact and Approximate Methods of Fly-Wheel Computation (Die Genaue und die Angenäherte Schwungradermittlung). Dr. R. Proell. An examination of the graphical and analytical methods of computing fly-wheel weights for given cylinder conditions. 2000 w. Zeitschr d Ver Deutscher Ing—Oct. 21, 1905. No. 73-301 D.

Gearing.

On the Location of the Pitch Circle in Worm Gearing. Ralph E. Flanders. Points out the limitations to the recommendations made by Mr. Perrigo and Mr. Edgar. Ills. 2700 w. Mach, N Y—Nov., 1905. No. 72941 C.

Governors.

Centrifugal Governors (Les Régulateurs à Force Centrifuge). L. Rith. A general study of the principles involved in the design of centrifugal governors for the speed regulation of prime movers. 10000 w. Mem Soc Ing Civ de France—Sept., 1905. No. 73334 G.

Power Distribution.

See Electrical Engineering, Distribution.

Wind Power.

The Electrical Value of Wind Power. Editorial Review of what has been accomplished in the electrical utilization of wind power. 1500 w. Sci Am—Nov. 18, 1905. No. 73203.

The Mechanical Effect Produced by Windmills (Sur le Travail Mécanique Fourni par les Moulins à Vent). M. Ringelmann. Data and results of tests upon a windmill used for pumping water. The velocity of the wind and the rotative speed of the wheel were recorded automatically. 1200 w. Comptes Rendus—Oct. 30, 1905. No. 73326 D.

STEAM ENGINEERING.

Boiler Appliances.

Improvements in Steam-Boiler Operation (Neuerungen im Dampfkesselbetriebe). Describing especially a filter for removing oil from feed water; also boiler cleaning appliances. 1200 w. Glückauf—Oct. 21, 1905. No. 73339 D.

Boiler Explosion.

Explosion of a Locomotive at the St. Lazare Station, Paris (Explosion d'une Locomotive aux Abords de la Gare Saint-Lazare, Paris). Ch. Frémont. With photographs of the fragments and a discussion of the probable manner and cause of an explosion which occurred July 4, 1904. 2500 w. Génie Civil—Oct. 21, 1905. No. 73310 D.

Boilers.

Some Notes on Steam Boiler Troubles. Horace See. Shows how some of the troubles can be directly traced to bad design and points out the characteristics found responsible for their occurrence. 2 plates. 2000 w. (No. 10). Soc Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73192 C.

The Dürr Water-Tube Boiler in H. M. S. "Roxburgh." Illustrations with description and report of trials. 1600 w. Engng—Nov. 3, 1905. No. 73132 A.

Coal Handling.

See Mechanical Engineering, Power and Transmission.

Compression.

Efficiency in Compression in Steam Engines. Prof. Robert H. Smith. Discusses the most efficient limit of compression, the efficiency being measured by horse-power per unit quantity of steam used per hour. 2500 w. Engr, Lond—Nov. 3, 1905. No. 73135 A.

Condensers.

Condensers for Steam Engines and Turbines. Frank Foster. Points out the general principles underlying condenser design, showing how the working conditions affect the design; especially considering the most economical vacuum. Ills. 3500 w. Mech Engr—Oct. 28, 1905. Serial. 1st part. No. 72997 A.

Draft.

Natural and Induced Draft. John W. Cobb. Read before the Yorkshire Sec. of the Soc. of Chem. Ind. An explanation of how a chimney does its work, and also a discussion of induced draft and its advantages. 2500 w. Prac Engr—Oct. 27, 1905. Serial. 1st part. No. 72993 A.

Engines.

German Rolling Mill Engines and Their Design. An illustrated article discussing single cylinder engines, compound engines, and triple expansion engines. 1800 w. Ir & Coal Trds Rev—Nov. 3, 1905. Serial. 1st part. No. 73138 A.

600 Horse-Power Horizontal Tandem Compound Condensing Engine. Illustrated description of an engine for driving directly a Jaspar dynamo. The combined plant is ordered for the Mechlin Locomotive Works. 1500 w. Engr, Lond—Nov. 10, 1905. No. 73295 A.

Exhaust Steam.

Increasing Profits of a Central Station. George E. Walsh. Calls attention to methods of economizing by utilizing exhaust steam, hot water circulating systems, etc. 2500 w. Am Elect'n—Nov., 1905. No. 73055.

Firing.

Is Machine Stoking Economical? Alfred W. Bennis. Abstract of a paper read before the Keighley Assn. of Engrs. Gives facts tending to prove the economy. 1700 w. Elect'n, Lond—Oct. 27, 1905. No. 73004 A.

The Burning of Fuel. Editorial on the burning of coal, especially in locomotives, and the effect of large grate area. 1000 w. Ry & Loc Engng—Nov., 1905. No. 72933 C.

Fuel.

The Utilization of Low Grade Fuels for Steam Generation. W. Francis Goodrich. A comparison of the theoretical value of high grade and low grade fuels on the basis of economy in money. 3500 w. Engineering Magazine—Dec., 1905. No. 73373 B.

Gas Firing.

Natural Gas Under Steam Boilers. Jay M. Whitham. Gives the results of the author's investigations. The tests show that the best coal efficiency cannot be obtained with gas. 2500 w. Trans Am Soc of Mech Engrs (No. 078)—Dec., 1905. No. 73444.

Lubrication.

Engine Friction and Lubricants. R. T. Strohm. Discusses the effect of friction, the theory and the action of a lubricant, the selection of lubricants, and their use. 2000 w. Am Elect'n—Nov., 1905. No. 73056.

Oil Fuel.

A Good Way to Burn Oil. E. H. Notthoff. Describes the method used with success by the writer. Ills. 1200 w. Engr, U S A—Nov. 15, 1905. No. 73260.

Some Observations on Oil Burners. John J. Smith. An account of experiments with these burners. Ills. 1800 w. Am Mach—Vol. 28. No. 45. No. 73075.

Steam.

The Thermal Properties of Saturated and Superheated Steam Between 100 and 180 Degrees (Die Thermischen Eigenschaften des Gesättigten und des Ueberhitzten Wasserdampfes zwischen 100 und 180 C.). O. Knoblauch, R. Linde and H. Klebe. An account of researches repeating the work of Regnault, at the Technical High School at Munich. Two articles. 10000 w. Zeitschr d Ver Deutscher Ing—Oct. 21, 28, 1905. No. 73300 each D.

Steam Pipes.

Steam-Pipe Arrangements. William H. Fowler. A discussion of the leading principles that should govern the design and arrangement of steam-pipe installations. 2000 w. Mech Engr—Nov. 4, 1905. Serial. 1st part. No. 73126 A.

Superheating.

A Study of a Semi-Portable Compound Engine with Double Superheating (Étude sur un Type de Locomobile Demi-Fixe Compound avec Double Surchauffe). Ch. Dantin. A report of tests on the Wolf compound engine with intermediate superheater. The thermal efficiency was 19.5 per cent. 2000 w. Génie Civil—Oct. 28, 1905. No. 73314 D.

Turbines.

Design and Construction of Steam Turbines. Frank Foster. The articles are intended to go beyond the popular description of turbines, but not to be so deeply involved in mathematics as to be above the intelligence of the practical engineer. 1800 w. Mech Engr—Oct. 28, 1905. Serial. 1st part. No. 72994 A.

Simple Steam Turbine Engines. John Richards. Read before the Tech. Soc. of the Pacific Coast. Explains types now in use, the main distinction between steam and water turbines, the action, and briefly reviews various engines showing the development. Ills. 4000 w. Am Mach—Vol. 28, No. 45. Serial. 1st part. No. 73077.

The New 1,000 K.W. Turbodynamo at the Courl Mine (Die Neue 1,000 K.W. Turbodynamo der Zeche Courl). F. Schulte. Describing a 1,500 h. p. Zoelly steam turbine, coupled to a Siemens-Schuckert alternator, the current being used in the Courl mine, in the Dortmund district. 2000 w. Glückauf—Nov. 11, 1905. No. 73342 D.

The Regenerator and Interheater System Applied to the Steam Turbine (Wärmerückführung und Zwischenheizung im Dampfturbinenbetriebe). J. Nadrowski and H. Dahlke. Describing the results obtained by the use of the regenerative principle in steam-turbine operation. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 11, 1905. No. 73322 D.

See also Marine and Naval Engineering.

Valve Gears.

A New Valve Gear Embodying a Novel Mechanical Movement. Illustrates and describes an interesting valve gear recently designed by E. J. Armstrong, of the Ball Engine Co., Erie, Pa. 1400 w. Mach, N Y—Nov., 1905. No. 72939 C.

Correcting a Faulty Valve Gear. H. A. Davis. Describes method and shows results. 800 w. Engr, U S A—Nov. 1, 1905. No. 72952 C.

Marshall's Valve Gear. Illustrated detailed description of a successful valve gear, the invention of James T. Marshall. 2000 w. Engr, Lond—Nov. 3, 1905. No. 73137 A.

Valves.

The Globe Valve—Its Origin and Development. J. O'Meara. An illustrated account of the origin and development of this steam valve. 1000 w. Heat & Vent Mag—Nov., 1905. No. 73264.

Various Applications of Balanced Cylindrical Slide Valves (Verschiedene Verwendungen des Entlasteten Rohrschieberventiles). F. Strnad. With illustrations of a variety of steam valves using tubular piston devices to relieve the steam pressure. 3000 w. Zeitschr de Ver Deutscher Ing—Nov. 4, 1905. No. 73308 D.

MINING AND METALLURGY

COAL AND COKE.

Coal.

Coal; Its Uneconomic Use and Abuse. John Livingstone. Discusses its uneconomic use and abuse generally, by steam makers, but especially by the railways, and how to save 50 per cent. Also general discussion. 17000 w. Pro St. Louis Ry Club—Oct. 13, 1905. No. 72979.

Coalfield.

The West Moreton (Ipswich) Coalfield. Walter E. Cameron. A report of the chief producing coalfield of Queensland, with special reference to the Bundamba district. 4500 w. Queens Gov Min Jour—Sept. 15, 1905. Serial. 1st part. No. 72975 B.

Coal Handling.

See Mechanical Engineering, Power and Transmission.

Coal Resources.

Coal Resources Along the Line of the Moffat Road. Arthur Lakes. Describes the two principal sources of coal along the route of this railway, the character and quality of the coal, and the general geology of the region. 1600 w. Min Wld —Nov. 11, 1905. Serial. 1st part. No. 73116.

Coal Trade.

See Industrial Economy.

Explosion.

The Clydach Vale Explosion, South Wales. James Ashworth. An account of this explosion, showing weak points of watering, and of construction in safety lamps. Ills. 3700 w. Mines & Min—Nov., 1905. No. 73032 C.

Peat.

The Application of Peat-Fuel. L. A. Stillings. Gives information concerning peat and its use, the large deposits in the United States, and the methods of preparing it for fuel, describing some processes. 2500 w. Elec-Chem & Met Ind—Nov., 1905. No. 73071 C.

The Present Status of the Peat-Fuel Industry in the United States. A. Frederick Collins. An illustrated description of the new fuel plant at New Rochelle, N. Y., and general information concerning peat-fuel. 2500 w. Sci Am Sup—Nov. 18, 1905. No. 73205.

Submarine Mining.

Submarine Coal Mining. A. Selwyn-Brown. Information concerning the dangerous risks in the submarine mines of New South Wales, due to the thinness and insecurity of the cover. 500 w. Eng & Min Jour—Nov. 18, 1905. No. 73237.

Testing.

Coal Testing. Myles Brown. On the value of true sampling, the methods and articles required; the apparatus for the analysis of coal, estimation of moisture, &c. 3000 w. Mines & Min—Nov., 1905. Serial. 1st part. No. 73034 C.

Thin Veins.

Mines Nos. 1 and 2 of the National Mining Co. James Collins. Illustrated description of the two best equipped mines in the Pittsburg thin-vein district. 2500 w. Mines & Min—Nov., 1905. No. 73030 C.

COPPER.

Copper Slag.

A Co-operative Analysis of a Copper Slag. Thorn Smith. A report showing the need of better chemical work by practical demonstration. 4000 w. Elec-Chem & Met Ind—Nov., 1905. Serial. 1st part. No. 73069 C.

Cyanides.

The Double Cyanides of Copper. Leonard M. Green. Explains tests for determining the cupric- and cuprous-potassium cyanides. 900 w. Eng & Min Jour—Nov. 18, 1905. No. 73243.

Mexico.

Plant of the Cananea Con. Copper Co., Cananea, Sonora, Mexico. O. P. Findley. Illustrated description of an efficient plant averaging about 6,000,000 lbs. per month. 1800 w. Min & Sci Pr—Nov. 18, 1905. Serial. 1st part. No. 73473.

GOLD AND SILVER.

Amalgamation.

The Separation of Silver from Sulphide in Amalgamation Processes (Ueber die Absscheidung des Silbers aus Schwefelsilber in Amalgamationsverfahren). Tosio Watanabe. A review of practice in Europe and America in comparison with results at Sado, in Japan. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 11, 1905. No. 73346 D.

Borneo.

The Occurrence of Gold in Upper Sarawak. J. S. Geikie. Read before the Inst. of Min. & Met. An illustrated description of the auriferous deposits occurring in the neighborhood of Bau and Bidi, in upper Sarawak. 3500 w. Min Jour—Nov. 18, 1905. Serial. 1st part. No. 73460 A.

Cyanide.

Notes on Improvements in the Cyanide Treatment of Sands and Slimes. C. H. Pead. Gives suggestions from the writer's experience. 1400 w. Jour Chem, Met, & Min Soc of S Africa—Sept., 1905. No. 73123 E.

Dredging.

Dredging for Gold in the Nome Goldfields. Otto Halla. A brief account of the successful working of this field. 700 w. Min & Sci Pr—Nov. 18, 1905. No. 73474.

Egypt.

Gold Mining in Egypt. An illustrated article describing the ancient methods of mining, and reviewing the history of these mines. 2200 w. Min & Sci Pr—Nov. 11, 1905. No. 73233.

Feeders.

An Improvement on Swinging Feeders in Stamp Mills. Paul J. Johnson. Gives a sketch and explanatory notes of a scheme for improving the action of such feeders. 500 w. Min Rept—Nov. 23, 1905. No. 73475.

Goldfields.

Talgai and Thane's Creek Goldfields. Lionel C. Ball. Notes on the mines of these fields. 5000 w. Queens Gov Min Jour—Oct. 14, 1905. No. 73453 B.

Ore Reduction.

Description of the Ore Reduction Plant and Process of Reduction on the Oroya-Brownhill Gold Mines. Robert Allen. Describes the character of the ores and gives a sketch plan of the plant. The Diehl process is used. 4000 w. Min Jour —Oct. 28, 1905. No. 73005 A.

Ore Treatment.

Plant for the Handling and Treatment of Ores, at the Silver Cup and Nettie L. Mines, British Columbia. George Attwood. Describes the scheme for the transportation of the ore and extraction of the metals on the spot in a mountainous district where the climate is severe. 5000 w. Ills. (No. 3486.) Inst of Civ Engrs. No. 73177 N.

Rhodesia.

Four Typical Rhodesian Gold Mines. Theo. F. Van Wagenen. Illustrations, with brief descriptions of the Tebekwe, the Wanderer, the Bonsor, and the Veracity mines. 1000 w. Min & Sci Pr—Nov. 4, 1905. No. 73107.

The Mines of Rhodesia. J. H. Curle, in *The Economist.* An explanation of the condition of the gold mines, leaving the conclusions to the reader. 1200 w. Eng & Min Jour—Nov. 4, 1905. No. 73017.

Silver-Cobalt.

The New Silver-Cobalt District of Ontario, Canada. Chauncey E. Butler. An account of the recent remarkable discoveries of cobalt, nickel, and silver ore. 800 w. Min Rept—Nov. 2, 1905. No. 73042.

Sluice.

Sluice Building on Placer. Dennis H. Stovall. Calls attention to important features in the construction of a sluice. Ills. 900 w. Min Wld—Nov. 4, 1905. No. 73045.

Smelting Works.

Britannia Smelting Co.'s Smelting Works at Crofton, Vancouver Island, B. C. Illustrated description of the works and their equipment. 2500 w. B C Min Rec—Oct., 1905. No. 73255 B.

Tonopah.

The Geology of Tonopah. J. E. Spurr. Outline of Professional Paper No. 42, U. S. Geol. Surv. A report of the geology of this region. 1800 w. Eng & Min Jour—Nov. 18, 1905. No. 73240.

IRON AND STEEL.

Australia.

Australian Iron and Iron Ore. John Plummer. Reviews the industry, its development and future outlook. 1500 w. Min Wld—Nov. 4, 1905. No. 73044.

Blast Furnaces.

Some Mexican Charcoal Blast-Furnaces. John Birkinbine. An illustrated article giving information of some of the older plants which depend upon charcoal as fuel. 1400 w. Cassier's Mag—Nov., 1905. No. 72985 B.

Desulphurization.

Experimental Desulphurization. Reginald Meeks. Describes experiments made with manganese ore, and considers the use of low sulphur materials, and the use of ferro-manganese in the ladles or in the cupola to be the only positive methods of obtaining low sulphur in castings. 2000 w. Ir Age—Nov. 9, 1905. No. 73053.

Dry Air Blast.

Dry Air for Blast Furnaces. Abstracts of unpublished papers presented at the Liége Mining and Metallurgical Congress. 3000 w. Ir Age—Nov. 16, 1905. No. 73146.

Furnace Gas.

An Improved Device for Cleaning and Cooling Blast Furnace Gas (Ein Neuer Reinigungs und Kühlapparat für Hochofengase). F. Krull. A description of the Bian apparatus, in which the gas is passed through perforated discs revolving in a closed cylindrical tank containing water. 1200 w. Glückauf—Oct. 28, 1905. No. 73340 D.

Furnace Hoist.

Electrical Blast Furnace Hoist. Illustrates and describes a plant at work in Germany. 1600 w. Engr, Lond—Nov. 10, 1905. No. 73296 A.

Grinding.

Grit Mills and Pans. Gives results of a series of trials between the grit mill and grinding pans at the Ivanhoe Gold Corporation, Kalgoorlie (W. A.). 2400 w. Aust Min Stand—Oct. 18, 1905. No. 73276 B.

Heat Treatment.

See Mechanical Engineering, Materials.

Hematite.

Occurrence of Hematite North of Little Current, Georgian Bay. S. Dillon-Mills. Describes the geology of the region, the minerals found, and discusses the chances for making the mining a financial success. Ills. 2200 w. Can Min Rev—Nov., 1905. No. 73200 B.

Iron Ore.

The Great Deposit of Iron Ore at Parapara, New Zealand. James MacIntosh Bell. An illustrated article describing extensive deposits of hematite ore. 1200 w. Ir Trd Rev—Nov. 23, 1905. No. 73413.

Iron Industry.

See Industrial Economy.

Manganese.

Manganese in Iron and Steel. A. A. Read. A comparison of some methods for the determination of manganese in iron and steel. 900 w. Engng—Oct. 27, 1905. No. 73008 A.

Open Hearth.

The Bertrand-Thiel Open Hearth Steel Process (Le Procédé Bertrand-Theil pour la Fabrication de l'Acier sur Sole). A general account of the double-furnace process, with details of the practical results at Kladno. 2500 w. Génie Civil—Nov. 4, 1905. No. 73317 D.

Ore Supply.

The Iron Ore Supply of the World. Interesting data from reports of Prof. Törnebohm to the Swedish Parliament, and of other reports by experts. Map. 2500 w. Ir Age—Nov. 2, 1905. No. 72936.

Rail Mill.

The Republic Iron and Steel Company's Rail Mill. Illustrated description of a mill at Youngstown, Ohio, where conditions compelled unusual engineering skill. 1500 w. Ir Age—Nov. 9, 1905. No. 73052.

Sampling.

Cargo Sampling of Iron Ores at Lake Erie Ports. W. J. Battle & Son. Read at meeting of the L. Sup. Min. Inst. Explains how samples are taken, advocating large samples, and giving the methods of analysis used. 2500 w. Ir Age—Nov. 2, 1905. No. 72937.

Silicon.

The Microstructure of Silicon and Alloys Containing Silicon. A. B. Albro. An illustrated report of investigations made under the direction of Henry Noel Potter. 1800 w. Elec, Chem & Met Ind—Nov., 1905. Serial. 1st part. No. 73072 C.

Spanish Mines.

The Alquife Iron-Ore Mines, in the South of Spain. George Harley Bulmer. Describes these mines and their working. 1000 w. (No. 3496.) Inst of Civ Engrs. No. 73164 N.

The Iron Ore Deposits of Spain (Der Eisenerzreichtum Spainens). Oskar Simmersbach. A review of the valuable iron ore beds of Spain, with chemical analyses, and tabulated data concerning exports. 3500 w. Glückauf—Nov. 4, 1905. No. 73341 D.

MINING.

Boring.

Improved Boring Appliances Shown at the Liége Exposition (Neue Bohrapparate auf der Lütticher Weltausstellung). Fritz Krull. Describing especially the Wolski hydraulic rock drill, and the Frieh & Nollenburg system for sinking shafts. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 21, 1905. No. 73343 D.

The Recovery of a Diamond Crown from a Deep Bore-hole. Cuthbert Baring Horwood. Describes a recovery from a depth of 3,233 feet. Ills. 800 w. (No. 3473.) Inst of Civ Engrs. No. 73168 N.

Cableways.

The Aërial Tramways at the Silver Cup Mine. George Attwood. Abstract of a paper in *Pro. of the Inst. of Civ. Engrs.* Illustrates and describes four tramways for conveying mining and food supplies, mining timbers and firewood, as well as passengers. 1600 w. Eng & Min Jour—Nov. 4, 1905. No. 73019.

Concentration.

Concentrating in the Western Kentucky District. Abstract of a paper read by F. Julius Fohs, at Marion, Ky., in regard to the problem of separating fluor spar from lead and zinc ores. 1500 w. Mines & Min—Nov., 1905. No. 73035 C.

Death Valley.

Notes on Death Valley and the Panamint. George D. James. An illustrated account of a trip to this region. Map. 3000 w. Eng & Min Jour—Nov. 18, 1905. No. 73238.

Drainage.

Drainage of the Cripple Creek District. D. W. Brunton. A report prepared for a committee appointed by Cripple Creek mine owners, giving interesting information concerning the tunnels, their cost, location, etc. Ills. 4500 w. Eng & Min Jour—Nov. 4, 1905. No. 73018.

Dredge.

An Improved Dipper Dredge. F. F. Coleman. Illustrated description of a new dipper dredge made by the Allis-Chalmers Company. 1000 w. Eng & Min Jour—Nov. 25, 1905. No. 73450.

Drilling.

Recent Improvements in Core Drilling Without Diamonds. Lucius I. Wightman. Briefly describes the Davis system, and improvements added. Ills. 1200 w. Eng & Min Jour—Nov. 4, 1905. No. 73022.

Egypt.

Mining and Use of Metals by the Ancient Egyptians. Prof. R. D. George. Information on this subject gathered from many sources. 7000 w. Pop Sci M—Dec., 1905. No. 73419 C.

Electric Power.

Improvements in Electric Operation of Coal Mines. George E. Walsh. An account of the operation of the mines in the vicinity of Scranton and Wilkesbarre, where electricity is generated at a central station and distributed for mine operation. 2200 w. Min Wld—Nov. 25, 1905. No. 73472.

See Electrical Engineering, Distribution.

Exposition.

Mining at the Liége Exposition (Der Bergbau auf der Lütticher Weltausstellung). F. Herbst. An extended descriptive and critical review of the mining appliances and methods shown at the exposition. Serial. Part I. 4000 w. Glückauf—Oct. 21, 1905. No. 73338 D.

Management.

A Puncher Machine Mine. Charlton Dixon. Discusses some of the difficulties of management and their causes, with suggestions for obtaining the greatest efficiency of plant. 5000 w. Mines & Min—Nov., 1905. No. 73039 C.

Mexico.

Geology of Sonora, Mexico. F. J. H. Merrill. Information concerning the geological formations. 1200 w. Eng & Min Jour—Nov. 25, 1905. No. 73451.

Mica.

Mica. Phillips Thompson. A description of a monograph on mica, by Fritz Cirkel, with information from this source. 2000 w. Eng & Min Jour—Nov. 4, 1905. No. 73021.

Mining.

Legitimate and Illegitimate Mining. Thomas Tonge. Abridged report of an address before the Students' Technical Society of the Colorado School of Mines. 4500 w. Min Jour—Nov. 11, 1905. No. 73285 A.

Mining Methods.

Coal Mining Methods. The characteristics of the deposits, which determine the method of mining, are described; the room-pillar and long-wall systems and their modifications, stating the conditions favoring long-wall mining. 2000 w. Eng & Min Jour—Nov. 18, 1905. No. 73242.

Mining Properties.

Examining Mining Properties. Prof. Arthur Lakes. Suggestions as to methods of proceeding and facts to be included in reports on properties. Ills. 1600 w. Mines & Min—Nov., 1905. No. 73037 C.

Orebodies.

Large Orebodies in Australia—Mining Methods. A. Selwyn Brown. A brief sketch of some of the more important methods adopted. 1500 w. Eng & Min Jour—Nov. 25, 1905. No. 73447.

Prospecting.

Churn-Drill Prospecting. George C. McFarlane. Illustrates and describes a gas-pipe churn-drill, cutting a 2 or a 2½-in. hole, useful in prospecting to moderate depths, where the country rock is not especially hard. 2000 w. Eng & Min Jour—Nov. 18, 1905. No. 73239.

Pumping.

Electric Pumping at Collieries. Gerald Hooghwinkel. Abstract of a paper read before the Manchester Geol. & Min. Soc. Considers the types of pumps, the electric motors, efficiency, and electric sinking pumps. 4000 w. Col Guard—Nov. 17, 1905. No. 73481 A.

Pyrite.

A Noted Pyrite Deposit. W. H. Storms. An account of the occurrence of sulphide ore in Whizzers mine, at Deadwood, S. D. 1200 w. Min & Sci Pr—Oct. 28, 1905. No. 73050.

Safety Lamps.

Recent Experiments on Safety Lamps (Nouvelles Expériences sur les Lampes de Sureté). H. Schmerber. Describing the appliances and results at the testing station at Frameries, Belgium. The lamps are exposed to explosive gases drawn from the mines. Two articles. 3000 w. Génie Civil—Oct. 21, 28, 1905. No. 73-312 each D.

Shafts.

Noteworthy Shaft Sinking at Detroit. An account of conditions that made the work very difficult, and the final success in sinking a shaft, where for 20 years every attempt had proved a failure. 1200 w. Ir Age—Nov. 16, 1905. No. 73147.

Mine Surveying. C. A. S. Andrews. Read at meeting of the Queensland Inst. of Surveyors. Detailed description of the method the writer has found to be best for an underground survey. 2500 w. Queens Gov Min Jour—Sept. 15, 1905. Serial. 1st part. No. 72974 B.

Surveying Secondary Mine Openings. Floyd L. Burr. Read before the L. Sup. Min. Inst. A brief description of a method used by the writer, and as accurate as is necessary for the work for which it is used. 1000 w. Eng & Min Jour—Nov. 11, 1905. No. 73103.

Switchgear.

Colliery and Mining Switchgear for High and Low Tension Alternating Current Service. A. M. Randolph. Describes a special line of switchgear and control apparatus for use in connection with mining operations. 1400 w. Elec Rev, Lond—Nov. 3, 1905. Serial. 1st part. No. 73128 A.

Unwatering.

Unwatering of the Achddu Colliery. John Morris. Abstract of a paper read before the Inst. of Min. & Met. Gives an account of the work, describing the pumps used and stating the difficulties. 3000 w. Min Jour—Nov. 11, 1905. No. 73284 A.

Unwatering the Hamilton Mine. John T. Jones. Read before the L. Sup. Min. Inst. An interesting account of the work of unwatering the mines at Iron Mountain, Mich. 1200 w. Eng & Min Jour—Nov. 11, 1905. No. 73104.

Utah.

Mineral Resources of Uintah Reservation. William S. Smith. Information concerning the deposits of this region in Utah. Copper, silver and lead and valuable deposits of the hydrocarbons. Map. 1000 w. Min Wld—Nov. 4, 1905. No. 73043.

Veins.

Fissure-Veins. R. W. Raymond. A contribution to a discussion of the question, What is a fissure-vein? 1200 w. Eng & Min Jour—Nov. 25, 1905. No. 73446.

Winding Engine.

New Winding Engine at the Sacré Madame Mines, Belgium (Nouvelle Machine d'Extraction à Vapeur des Charbonnages de Sacré-Madame, Belgique). L. Ramakers. Illustrating a double horizontal winding engine shown at the Liége exposition. 1500 w. 1 plate. Génie Civil —Nov. 11, 1905. No. 73318 D.

MISCELLANY.

Asbestos.

Asbestos in Canada. Abstract of a monograph recently published by the Mines Bureau of the Dominion, giving information concerning the valuable deposits in Quebec. Ills. 1400 w. Eng & Min Jour—Nov. 18, 1905. No. 73241.

Furnaces.

Heat Insulation. R. S. Hutton and J. R. Beard. Describes experiments to determine the relative value of heat-insulating materials used for the bricks or linings of furnaces. Diagrams. 1700 w. Eng Rec—Nov. 25, 1905. No. 73494.

Solutions.

Solutions of Solids and Solid Solutions. J. H. Stansbie. Abstract of paper read before the Met. Soc. at the Birmingham, Eng., Munic. Tech. School. A study of the changes which refer to the solid and liquid states of metals. 2500 w. Mech Engr—Nov. 18, 1905. No. 73454 A.

Zinc.

The Concentration and Separation of Zinc-Lead Ores as Practiced in Summit County, Colorado. Illustrates and describes a plant at Breckenridge, Colo. 800 w. Min Rept—Nov. 16, 1905. No. 73267.

The Estimation of Zinc. H. Nissenson and W. Kettembeil. Abstract of a paper in *Chemiker Zeitung*. Gives a review of the volumetric methods and a report of experiments of the authors. 3000 w. Eng & Min Jour—Nov. 25, 1905. No. 73449.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Derailments.

Unexplained Derailments. G. H. List. Gives an account of some experiences gained during 13 years of service, which offer explanations for some accidents. 1500 w. Engr, Lond—Nov. 3, 1905. No. 73134 A.

Explosives.

An Expert Report on the Transportation and Handling of Explosives by Railways. Full abstract of Dr. Charles B. Dudley's report, and of the report of the Committee of Experts. 8500 w. Eng News—Nov. 9, 1905. No. 73083.

Regulations for the Transportation of Explosives. Gives the regulations drafted by the committee of the Am. Ry. Assn. and approved at Chicago, Oct. 25, 1905. 3500 w. Eng News—Nov. 23, 1905. No. 73426.

South Africa.

The Cape Government Railways. Abstract of a paper by A. M. Tippett, read before the British Assn. at Cape Town, which gives information in regard to the working of these lines. Ills. 1800 w. R R Gaz—Vol. XXXIX., No. 20. No. 73224.

MOTIVE POWER AND EQUIPMENT.

Air-Brakes.

Air-Brakes in Freight Train Service. Abstract of the testimony recently presented at Washington by the representatives of various railway companies opposing the proposed increase in the number of air-brakes required on freight trains. 2200 w. Eng News—Nov. 9, 1905. No. 73086.

Percentages of Freight Cars Air Braked. Information in tabulated form showing how many cars are air-braked on the different roads, and how well the trains have been air-braked during the past six months. 1000 w. R R Gaz—Vol. XXXIX., No. 19. No. 73090.

Car Lighting.

See Electrical Engineering, Lighting.

Cars.

A Combination Stock and Drop-Bottom Dump Car. Illustrates and describes a new type of 80,000-lb. stock car, intended primarily for coal or coke service when not carrying stock. 600 w. R R Gaz—Vol. XXXIX., No. 18. No. 72977.

50-Ton Steel Twin Hopper Gondola Car. Illustrates and describes cars almost entirely of structural steel, and having several departures from ordinary designs. 1,000 have been received by the L. S. & M. S. Ry. 1500 w. Am Engr & R R Jour—Nov., 1905. No. 72944 C.

Large Freight Cars (Güterwagen von Hoher Tragkraft). E. Metzeltin. With numerous illustrations of flat top, box, and hopper cars of the largest sizes in German, British, and American railway service. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 4, 1905. No. 73307 D.

New Types of Railway Rolling Stock (Quelques Nouveaux Types de Materiel de Chemins de Fer). H. Chevalier. Describing some new coaches and sleeping cars of the Western Railway of France. 2500 w. 1 plate. Mem Soc Ing Civ de France—Sept., 1905. No. 73337 G.

Steel Cars for the New York Central's Electric Suburban Service. Illustrated description of all-steel cars. 1500 w. R R Gaz—Vol. XXXIX., No. 18. No. 72978.

Draft Gears.

Friction Draft Gear. R. H. Blackall. Reviews the development, discussing the uses, advantages, cost, &c., comparing the results of twin and friction gears in service. 3000 w. 1 table and fig. Bul Int Ry Cong—Oct., 1905. No. 73403 F.

Hospital Car.

Hospital Car for the Southern Pacific. Illustrated description of a handsome special car, which is arranged for hospital service, but so constructed that it can be used as a private car. 1000 w. Ry Age—Nov. 3, 1905. No. 73047.

Locomotives.

A Lehigh & New England Rebuild. Illustrates the engine before and after rebuilding, describing the changes. 500 w. Ry & Loc Engng—Nov., 1905. No. 72934 C.

Austrian 0-10-0 Locomotive. Karl Göldsdorf. Illustrated description of a design built in 1901 for the State Railways. Also some of the most recent designs. 400 w. Ry & Loc Engng—Nov., 1905. No. 72932 C.

Bogie Tank Locomotive, Madrid and Alicante Railways. Illustrates and describes double-bogie tank engines for heavy suburban service. 400 w. Engr, Lond—Nov. 17, 1905. No. 73463 A.

British Locomotives in 1904. Charles Rous-Marten. Discusses the designs and the good locomotive work. 6200 w. Ills. Bul Int Ry Cong—Oct., 1905. No. 73402 F.

Compound Freight Locomotive (Locomotive Compound à Marchandises). F. Barbier. Describing a double motor-bogie engine of 102 tons weight designed for the heavy coal traffic of the Northern Railway of France. 2000 w. 1 plate. Génie Civil—Oct. 28, 1905. No. 73313 D.

Compound Locomotives on the Great Western Railway. A. G. Robins. An interesting account of the work of the express locomotives of the Great Western Railway, and the results of test made with engines of the de Glehn type. Ills. 4500 w. Engng—Nov. 3, 1905. No. 73130 A.

Compound Locomotives with Superheaters. Illustrated description of a compound consolidation freight locomotive with superheater, for the Minneapolis, St. Paul & Sault Ste. Marie Ry. 1200 w. Eng News—Nov. 23, 1905. No. 73420.

Consolidation Locomotive for the Imperial Government of Japan. Illustrates the 2-8-6 type of locomotive, a number of which have been built in America for Japan. 500 w. Ry & Loc Engng—Nov., 1905. No. 72931 C.

Engine Equipments. R. Emerson. Gives a representative list of the appurtenances and appliances, discussing how to improve conditions, the cost of installing a new system, the method, &c. 3500 w. Am Engr & R R Jour—Nov., 1905. No. 72946 C.

Four-Cylinder Compound Freight Locomotive for the Swiss Railways (Vierzylinder Verbund Güterzug Lokomotive der Schweizerischen Bundesbahnen). M. Weiss. Illustrated description of a 66 ton counterbalanced compound engine for heavy freight service in Switzerland. 1800 w. 1 plate. Schweiz Bauzeitung—Oct. 21, 1905. No. 73332 B.

4-Cylinder Compound Locomotives in Belgium. Charles S. Lake. Reviews the tendencies of modern locomotive practice in Belgium, and gives illustrated descriptions of two heavy engines of great power recently built. 1500 w. Mech Engr—Oct. 28, 1905. No. 72995 A.

Four-Cylinder Express Locomotive for the London and South-Western Railway. Illustrated detailed description of a new and interesting engine designed by Mr. Drummond. 1000 w. Engng—Nov. 10, 1905. No. 73291 A.

4-6-0 Engine for the D., L. & W. Illustration and description of recently completed passenger engines designed to burn fine anthracite coal. 600 w. Ry & Loc Engng—Nov., 1905. No. 72928 C.

Heavy Duplex Compound Goods Locomotive. Photograph and sectional elevation, with description of one of two heavy articulated compound locomotives designed by Mons. de Bosquet, of the Northern Ry. of France. 900 w. Prac Engr—Oct. 27, 1905. No. 72992 A.

Heavy Ten-Wheel Passenger Locomotive for the Delaware, Lackawanna & Western R. R. Illustration, dimensions and brief description of a heavy (4-6-0) passenger engine. 500 w. R R Gaz—Vol. XXXIX., No. 20. No. 73230.

Performance of a Balanced Compound Locomotive, A. T. & S. F. Ry. Illustration, with report of very satisfactory work. 800 w. Ry & Engng Rev—Nov. 4, 1905. No. 73049.

Peter Cooper's Locomotive. A brief account of one of the earliest locomotives in America, running from Baltimore to Ellicott's Mills in 1830. 400 w. Ry & Loc Engng—Nov., 1905. No. 72927 C.

Six-Coupled Express Engines on the London & North-Western Railway. Charles Rous-Marten. Describes the latest locomotive designed for the express service of this road, explaining the difficult conditions between Crewe and Carlisle. 4500 w. Engr, Lond—Nov. 10, 1905. No. 73292 A.

The Steam Locomotive. J. K. Brassill. An illustrated review of its evolution and development as evidenced by the exhibits in the transportation building at the St. Louis World's Fair. 18500 w. Pro Pacific C Ry Club—Oct. 21, 1905. No. 72926 C.

Two Baldwin Four-Cylinder Balanced Compound Locomotives. Illustrated descriptions of two new types. An Atlantic (4-4-2) type engine, and a Pacific (4-6-2) engine. 500 w. R R Gaz—Vol. XXXIX., No. 19. No. 73088.

Vauclain 4-Cylinder Balanced Compound Atlantic Type Locomotive. Illustrated description of locomotives recently built for the C., R. I., & P. Ry. 400 w. Am Engr & R R Jour—Nov., 1905. No. 72947 C.

Repairs.

The Cost of Locomotive Repairs per 1,000-Ton Miles. Harrington Emerson. Does not consider it safe to generalize under existing conditions, suggesting the best way to cheapen engine repairs. 700 w. Am Engr & R R Jour—Nov., 1905. No. 72945 C.

Train.

South-Eastern & Chatham Express Train. Engraving and description of a fine British express train. 900 w. Loc Engng—Nov., 1905. No. 72930 C.

Valve Gears.

History of the Walschaerts Valve Motion. M. J. Boulvin. Translated from *Revue de Mécanique.* Ills. 1500 w. R R Gaz—Vol. XXXIX., No. 21. No. 73435.

NEW PROJECTS.

China.

Railroad Development in China. John Foord. Discusses the importance of Japan's victory over Russia in its effect upon China, and reviews the history of railroad building, and the present attitude of China toward the construction of railroads. Map. 4000 w. Ir Age—Nov. 23, 1905. No. 73400.

Cyprus.

Cyprus Government Railway. Outlines the history of this island of the Mediterranean and gives a map and description of the railway under construction, with illustrations, of the interesting features. 1800 w. Engr, Lond—Nov. 17, 1905. No. 73464 A.

Korea.

Opening Korea by Rail. Homer B. Hulbert. An illustrated account of the building of the Seoul-Fusan line, and the difficulties encountered. 3000 w. World's Work—Nov., 1905. No. 72921 C.

New Road.

A Feat in Railroad Building. Lawrence Lewis. An illustrated account of the "air line" from Denver to Salt Lake City, being built by D. H. Moffat, of Denver, Colo. It has 29 tunnels in 11 miles, with wonderful engineering work. 3400 w. World's Work—Nov., 1905. No. 72922 C.

Railroad Development.

The "Deepwater-Tidewater" Railroads. George W. Harris. Map and account of a system to extend from the head of navigation on the Kanawha River, to tidewater at Hampton Roads. 1200 w. Eng & Min Jour—Nov. 4, 1905. No. 73020.

PERMANENT WAY AND BUILDINGS.

China.

Railway Construction in North China. Edward Hulme Rigby and William Orr Leitch, Jr. A description of the Chinchou-Yingkow section, 97 miles in length. Ills. 18000 w. (No. 3509.) Inst of Civ Engrs. No. 73156 N.

Crossings.

A Graphical Method of Determining the Relative Positions of Points and Crossings. Charles John Albrecht. Brief description of method. 600 w. (No. 3489.) Inst of Civ Engrs. No. 73167 N.

New South Wales.

Early Railway Construction in New South Wales. Joseph Brady. Brief account of work from 1850 to 1857. 1800 w. (No. 3467.) Inst of Civ Engrs. No. 73158 N.

Retaining Wall.

Concrete Retaining Wall of the Illinois Central on the Lake Front, Chicago. Illustrations and description of the east wall now under construction, with outline of work previously completed. 1000 w. R R Gaz—Vol. XXXIX., No. 20. No. 73225.

Shops.

East Moline Locomotive Shops. Begins an illustrated detailed description of these five repair shops of the Rock Island system. 3000 w. Am Engr & R R Jour—Nov., 1905. Serial. 1st part. No. 72943 C.

Electric Drive in Locomotive Repair Shops. A. S. Atkinson. Describes the electric drive in the large car shops of the Buffalo, Rochester & Pittsburgh Ry. Co. at Du Bois, Pa., giving details of operation and results obtained. 2500 w. Ry & Loc Engng—Nov., 1905. No. 72929 C.

Signaling.

An English Electric System of Railway Signaling. F. C. Perkins. An illustrated description of the Webb & Thompson electric point and signal apparatus installed on the London & Northwestern Railway. Shows the devices used in one of the signal cabins at Crewe, which will contain more than 1,000 levers. 1800 w. Sci Am Sup—Nov. 11, 1905. No. 73093.

Terminals.

Electric Equipment and Reconstruction of the New York Terminal Lines and Grand Central Station, New York Central & Hudson River R. R. A finely illustrated article summarizing this great work now in progress which is to cost about $60,000,000. 12000 w. Eng News—Nov. 16, 1905. No. 73218.

Improvements of the New York Central & Hudson River Within the Electric Zone. G. R. Wadsworth. Illustrates and describes the Marble Hill cut-off, the Port Morris Branch depression, elimination of grade crossings and special station improvements, and the four-tracking of the Hudson and Harlem divisions. 2000 w. R R Gaz—Vol. XXXIX., No. 19. No. 73087.

Terminal Yard Improvements of the New York Central & Hudson River R. R. Briefly outlines the conditions at this terminal before the commencement of improvements, and gives an illustrated account of the extensive work in progress. 3000 w. Eng Rec—Nov. 18, 1905. No. 73247.

The Marble Hill Cut-Off and Port Morris Branch, New York Central Terminal Improvements. Gives a general review of the conditions at the New York terminal of the N. Y. C. & H. R. R. R., and within the territory to be operated by electricity, describing this enormous engineering undertaking which will approximate $60,000,000 in cost. Ills. 5000 w. Eng Rec—Nov. 4, 1905. No. 73061.

The New Weehawken Railroad Terminal Power Plant. Illustrated detailed description of an electric plant for the operation of the grain elevators, shops, &c., and the lighting of the large terminal yard and buildings of the West Shore R. R. 4500 w. Eng Rec—Nov. 11, 1905. No. 73145.

Track Elevation.

Kinzie Street Track Elevation of the Chicago & North-Western, Chicago. An illustrated description of an interesting piece of work with difficult features. 2000 w. R R Gaz—Vol. XXXIX., No. 19. No. 73089.

Transition Curves.

Setting Out and Checking Circular and Transition Curves in Railway Track. Illustrated description of a simple instrument, designed by F. A. Smith, by which the section foreman can check the accuracy of his curves. 1600 w. Eng News—Nov. 16, 1905. No. 73221.

Transition Curves on the Southern Pacific R. R. An explanation of methods employed by the engineering department of this road, illustrated by example. Diagram and tables. 1400 w. Eng Rec—Nov. 11, 1905. No. 73140.

Tunnels.

See Civil Engineering, Construction.

Water Tanks.

Protecting Railway Water Tanks from Freezing. Presents the available means of protecting water tanks as given in a committee report made to the Assn. of Ry. Supts. of Bridges & Bldgs. Ills. 1500 w. Eng News—Nov. 2, 1905. No. 72956.

Wilmington.

Pennsylvania Improvements at Wilmington, Del. Illustrates and describes extensive improvements, including a brick arched viaduct, massive stone retaining walls, plate girders, drawbridge, changes of track, a new passenger station and office building, etc. 2500 w. Ry Age—Nov. 3, 1905. No. 73048.

Yardmaster.

The Work of a Yardmaster. J. D. Tyler. Read before the New England R. R. Club. Discusses the qualifications and training needed and the character of the work. 2200 w. Ry & Engng Rev—Nov. 18, 1905. No. 73268.

TRAFFIC.

Clearing House.

Early Proposals to Form a Clearing House in Connection with Trunk Line Associations. J. W. Midgley. Reviews the various schemes for establishing a railway clearing house, explaining the views of various railway men. 5000 w. Ry Age—Nov. 10, 1905. No. 73102.

Freight.

Handling Fast Freight in England. An account of the extravagant development of this type of traffic in England. 2000 w. R R Gaz—Vol. XXXIX. No. 21. No. 73431.

Handling Freight so as to Avoid Losses. Extracts from an address on loss and damage and its effects upon railroad revenue, delivered to the freight agents of the N. Y. C. & H. R. R., by R. L. Calkins. 2200 w. R R Gaz—Vol. XXXIX. No. 19. No. 73091.

Time Freight on the Erie. Describes the system of handling and keeping a record of the movement of fast freight. The principle on which it is based is the grouping of cars containing freight of similar classification from one point to another point and making one manifest for the group of cars. 2000 w. R R Gaz—Vol. XXXIX. No. 20. No. 73227.

Locomotive Loading.

Loading of Locomotives on the Equated Tonnage of Drawbar-Pull Basis. J. M. Daly. Discusses the proper method of rating and loading locomotives, giving illustrated description of a computing device that automatically registers the number of cars in train and adjusts the drawbar-pull of each gross weight of car at each location in the train. Lengthy discussion of interest. 15500 w. Pro N Y R R Club—Oct. 20, 1905. No. 73409.

Ton-Mile.

Ton-Mile Railway Statistics, and Railway Rates and Terminal Charges. R. Price-Williams. Gives a tabular statement showing the value of the ton-mile principle as applied to ascertaining goods and mineral traffic receipts, with discussion of this and related subjects. 1500 w. Ir & Coal Trds Rev—Oct. 27, 1905. No. 73012 A.

MISCELLANY.

England.

Work of the English Railway and Canal Commission. Abstract of a paper by S. J. McLean in the *Quarterly Jour. of Economics*. Reviews the actual results obtained during the last 17 years by a body possessing many of the functions proposed for the Interstate Commerce Commission. 2500 w. R R Gaz—Vol. XXXIX. No. 21. No. 73436.

Railway Congress.

Official Information Issued by the Permanent Commission of the Railway Congress. Summary of the proceedings of the seventh session at Washington, D. C., 1905. 12600 w. Tables. Bul Int Ry Cong—Sept., 1905. No. 73401 H + F.

STREET AND ELECTRIC RAILWAYS

Apparatus.

Selection and Operation of Street Railway Apparatus. A. G. Rakestraw. The present article considers motors, trucks, gears, and methods of control. 3000 w. Sib Jour of Engng—Oct., 1905. Serial. 1st part. No. 73487 C.

Boston Elevated.

New Power-Station Equipment of the Boston Elevated Railway Company. Illustrates and describes equipment which will increase the present power supply 10 per cent. It includes a d. c. 2000-kw. turbo generator outfit to be added to the Dorchester station, a 875-kw. gas engine plant at Salem St. station, Medford; and a 700-kw. gas-engine plant for W. Somerville. 3000 w. St Ry Jour—Nov. 4, 1905. No. 73025 C.

Bournemouth.

Electric Traction at Bournemouth. Illustrates and describes a combined conduit and trolley system with extensions in three boroughs. 2800 w. Tram & Ry Wld —Nov. 9, 1905. No. 73492 B.

Cars.

The Standard Surface Car of the Brooklyn Rapid Transit Company. Illustrated detailed description of a car recently adapted for service in surface lines, which is quite a departure from the usual type of semi-convertible cars. 2000 w. St Ry Jour—Nov. 18, 1905. No. 73234 C.

Car Works.

Manchester Tramway Car Works. Brief illustrated description of a recently completed works in England. 1000 w. Tram & Ry Wld—Nov. 9, 1905. No. 73-491 B.

Depot.

Burnley Tramways Depot. Henry Mozley. Particulars and illustrations of the Queens' Gate depot and general offices which have recently been erected, equipped and placed in operation. 2000 w. Tram & Ry Wld—Nov. 9, 1905. No. 73490 B.

Electric Traction.

Development of Heavy Electric Traction. Discusses the subject as applicable to suburban service, favoring single-phase traction not only for long-distance lines, but for heavy suburban traffic. 1500 w. Elec Rev, Lond—Nov. 17, 1905. No. 73456 A.

Electric Traction. (Question VIII, 7th Session.) Victor Tremontani. Appendices to the report No. 4. Deals with accumulators, continuous current motors, three-phase current motors, monophase current motors, etc. 22300 w. 6 tables and Ills. Bul Int Ry Cong—Oct., 1905. No. 73-404 F.

Heavy Electric Railroading. Bela Valatin. A comparison of the direct current, the single-phase, and the three-phase systems, particularly for installations to be used for moving heavy train units, and where electricity is to replace the steam locomotive. 3000 w. Elec Wld & Engr—Nov. 18, 1905. No. 73245.

Electrification.

Electrification of the Long Island Railroad. S. D. V. Burr. Map and illustrated description of the extensive system of electrification recently completed. 2500 w. Ir Age—Nov. 2, 1905. No. 72935.

Electrification of the New York Suburban District of the New York Central & Hudson River Railroad. Illustrated descriptions of the power stations at Yonkers and at Port Morris, and of a typical sub-station, and their equipment and operation. 3800 w. Elec Rev, N Y—Nov. 11, 1905. No. 73113.

Improvements of the New York Central & Hudson River Within the Electric Zone. G. R. Wadsworth and J. C. Irwin. The present article gives an illustrated description of the electrical equipment. 5000 w. R R Gaz—Vol. XXXIX. No. 20. No. 73226.

Improvements of the New York Central and Hudson River Within the Electric Zone. G. R. Wadsworth. This article concludes a series, and describes and illustrates the new terminal building which will be erected on the site of the Grand Central Station. 1300 w. R R Gaz—Vol XXXIX. No. 21. No. 73433.

New York Central Electrification. Illustrates and describes the improvements which are in progress at the Forty-second Street terminal in New York City, to accommodate electric trains, and also the transmission system and sub-stations. 4200 w. St Ry Jour—Nov. 18, 1905. No. 73235 C.

Power Stations of the Electric Zone of the New York Central & Hudson River Railroad. Illustrates and describes the stations at Yonkers and Port Morris, with a typical sub-station and its equipment. 4000 w. St Ry Jour—Nov. 11, 1905. No. 73119 C.

The Electrification of the Long Island Railroad. An illustrated description of this important electrification of a steam road, and the complicated service. 4000 w. Eng Rec—Nov. 4, 1905. No. 73058.

The Electrification of the Long Island Railroad. Illustrates and describes the main features of this important installation. 3800 w. St Ry Jour—Nov. 4, 1905. No. 73024 C.

The Installation of Electric Traction on the Long Island R. R. An illustrated article giving a statement of the work thus far done. 4000 w. Eng News—Nov. 2, 1905. No. 72954.

English Practice.

English Electric Railway Practice. Particulars regarding features of recent permanent way and conductor rail work on roads changed from steam to electric traction. Ills. 2300 w. Prac Engr—Nov. 3, 1905. No. 73124 A.

Interurban.

Freight and Express Traffic on Interurban Railways. M. E. Graston. Read before the Indiana Elec. Ry. Assn. Discusses points in regard to increasing the business and handling the freight. Abstract of discussion. 2800 w. St Ry Rev—Nov. 15, 1905. No. 73212 C.

Locomotive.

A Storage-Battery Locomotive. Illustrated description of a novel type of electric locomotive designed for service on the new drop level tube for London that is in course of construction. 700 w. Sci Am—Nov. 25, 1905. No. 73414.

Loops.

Traffic Problems Upon Loops and Stub Tracks. Howard S. Knowlton. Presents equations covering the general cases most commonly encountered. 2700 w. St Ry Rev—Nov. 15, 1905. No. 73211 C.

Mono-Rail.

The Wetterhorn Electric Aerial Mono-Rail. A departure in mountain railway construction is illustrated and described. A stout wire cable forms the overhead mono-rail from which is suspended the running gear of the car body. 1000 w. Engr, Lond—Nov. 10, 1905. No. 73299 A.

N. Y. Subway.

The Sanitary Condition of the New York Rapid Transit Subway. Gives a reprint of the preliminary report of Dr. George A. Soper, with editorial comment. 2800 w. Eng News—Nov. 9, 1905. No. 73085.

Railway Test.

Test of the Railway System of the Scioto Valley Traction Company. F. C. Caldwell. The principal object of the test was to obtain a statement of the distribution of the power consumption and losses throughout the system during a normal day's run. 4800 w. St Ry Rev—Nov. 15, 1905. No. 73210 C.

Reconstruction.

The Reconstruction of the Topeka Railway. An account of a thorough reconstruction of the physical equipment, and reorganization of operating methods which brought such an increase in net earnings as made the returns on the investment entirely satisfactory. Ills. 2700 w. St Ry Jour—Nov. 11, 1905. No. 73120 C.

Single-Phase.

Single-Phase Electric Traction (La Traction Electrique par Courant Alternatif Simple). Describing the Auvert-Ferrand transformer for use directly upon the car. 1500 w. Génie Civil—Nov. 11, 1905. No. 73320 D.

Tests of Interurban Single-Phase Equipments. Graham Bright. Describes methods of testing, reporting tests taken recently. 1500 w. Elec Jour—Nov., 1905. No. 73406.

Snow.

Novel Swiss Combination Snow-Plow and Sweeper. Illustrated description of an efficient apparatus for the removal of snow. 500 w. St Ry Jour—Nov. 4, 1905. No. 73026 C.

Stray Current.

See Civil Engineering, Municipal.

Subway.

Proposed Subway in Berlin (Entwurf von Unterpflasterbahnen in Berlin). Plans for shallow subways in the central portion of the city, with map. 2500 w. Elektrotech Zeitschr—Oct. 26, 1905. No. 73352 B.

Surface Contact.

Surface Contact Systems. Brief discussion of the four systems on trial in England—the Lorain, the Dolter, the G. B., and the Kingsland. Ills. 2200 w. Elec Rev, Lond—Nov. 10, 1905. No. 73280 A.

Suspension Railway.

Design for a Suspension Railway in Berlin (Entwurf einer Elektrischen Schwebebahn für Berlin). Detailed account of a rapid transit system for Berlin, similar to the Barmen-Elberfeld line. 5000 w. Elektrotech Zeitschr—Oct. 26, 1905. No. 73351 B.

Switzerland.

The Sernf Valley Railway (Die Sernftalbahn). Illustrated description of the electric railway recently opened in the Sernf valley between Schwanden and Elm, above Glarus, Switzerland. Serial. Part I. 1500 w. Schweiz Bauzeitung—Nov. 11, 1905. No. 73333 B.

The Electric Railway of Gruyères. Emile Guarini. Illustrated description of a recent line in the canton of Freiburg, Switzerland. 2000 w. Engineering Magazine—Dec., 1905. No. 73377 B.

Topeka.

Topeka Railway Company. An illustrated description of the roadbed, shops, equipment, generating station and park. 4000 w. St Ry Rev—Nov. 15, 1905. No. 73209 C.

Wellington, N. Z.

Wellington City Tramways. An illustrated article describing the recent extensions and electrification of the tramway lines in this city of New Zealand. 4000 w. Tram & Ry Wld—Nov. 9, 1905. No 73489 B.

Wheel-Shop.

New Wheel-Shop of the New York City Railway Company. States the peculiar conditions which make the wheel problem a matter of great importance in New York, and gives an illustrated description of the new shop and its equipment. 2000 w. St Ry Jour—Nov. 25, 1905. No. 73452 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.

Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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THE AMERICAN, AND THE GERMAN, "PERIL."

By Louis J. Magee.

II. DIFFERENCES IN NATIONAL TRAITS AND INDUSTRIAL POLICY.

Mr. Magee's peculiar command of his topic—his intimate friendly comprehension of German industrial life and his loyal Americanism—were pointed out in his introduction last month. The present paper deals with matters which lie at the foundation of Germany's national ascendency.—THE EDITORS.

WERE this an attempt to draw up an international balance-sheet, we should not have much difficulty in finding some virtue to offset each disagreeable liability. In the young civilization of America one could point to intellectual triumphs of which maturer lands might well be proud. On the records even of Germany's financial life one could find some scandals; exceptions, compensations on every hand. This is however rather an appeal to Americans to study Germans as they study us. The true picture of Americanism is gradually developing before European eyes. What matter if at first some of our high-lights create a misleading effect?

Each visitor from Europe imagines that he has discovered his own fine *nuances* in the characterization of the American people and methods. One of them recently gave it as his opinion that the high standard of effort in American factories and offices was due to the fact that the rank and file of the workers were not accustomed to alcoholic stimulants.

Another keen German observer, in reality a great admirer of America, laughs at our national fondness for dimension. He says that it is almost impossible for an American to describe anything without some statement as to comparative measurements. A railroad is "the longest in the world," or hauls the "greatest number of tons of coal"; a water-fall is the "highest in the world." We must always speak of the highest building, the largest capital, the wealthiest man, the "greatest show on Earth," etc.

A cultivated banker, upon returning to Berlin, said to his associates:

"I was touched by the exceptional kindness of most of the Americans whom I met. They seemed so very trustworthy, and displayed a frankness in all business affairs that I have never known elsewhere. The optimism of the American is universal. I hunted 'with a lantern' for a pessimist, but found none.

"The business of prophets (clairvoyants, astrologers, palm readers, etc.) flourishes as in no other country. Some of the most beautiful churches belong to Faith Curists. The quality of the plays in the theater is, in general, of so low an order that they do not offer any intellectual charm to the European."*

The younger men who come over are carried off their feet by our outward signs of prosperity; by our business rush and our sublime recklessness in forging ahead for results without quibbling over means. They laugh at any crudeness and disorder as unimportant compared with ultimate attainment, because youth cares more for movement and progress than for comfort and solidity.

One of the points frequently noted is the tendency of American industries to make themselves independent in the supply of half-products and raw stuffs; as brought out, for instance, in the ownership by the U. S. Steel Corporation, of mines, steamers, and railways. The Germans are always astounded to find so many young men in positions of the highest responsibility in the United States. The gravest difficulty that capitalists have had during the recent years of German industrial activity, is to find the suitable men to take charge of great enterprises. The Government service has surrendered a few able men for such positions. Perhaps the most outspoken difference which Germans see between our home market and theirs, is that the greater luxury and higher standards of living in our country add enormously to those demands which would result in any case from the increase of population and general development of resources. Furthermore, the dearness of labor causes us to purchase new products rather than to spend time on the repair of what is only partly worn out.

Scientists abroad are inclined to consider us in advanced physical investigation as more "extensive" than "intensive." In how far the recent princely additions to our research facilities will better our already respectable record in this regard, it is difficult to forecast. Probably our rapidly improving standards of scholarship will mean more than any material advantages. The most critical element of European culture appreciates and admires much of our scientific work, and we all know that there is a large number of serious workers in our universities and Government bureaux; but, on the other hand, it cannot be controverted that our national impatience and eagerness for results seriously interferes with research in the sense that it is carried on in Europe. Some of our best private workers have been spoiled in a way by sudden prosperity; their productivity has decreased with increasing wealth.

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* "I would desire for my country three things above all others, to supplement our existing American civilization: from Great Britain her administration of criminal justice; from Germany her theater; and from any European country, save Russia, Spain, and Turkey, its government of cities."—*Autobiography of Andrew D. White.*

The research organization costs a great deal more to support in America than in Europe, for the reason that the comparatively few trained young scientists in our country get into highly remunerative positions with corporations, whereas in Germany there is a greater supply of trained men. It must not be thought, however, that the European professors are working alone for the love of science. Many of them are getting large incomes by giving expert advice and making practical designs for various branches of industry. But these financially sucessful ones seem still to specialize, and to work persistently, with their increased means, within the limitations of their own subjects.

The best informed and most impassionate German observers believe that we shall always be their sharp competitors, but they see nothing in our industrial development, as compared with their own, to make them "fall on their backs," as they put it. The American danger does not seem imminent, but they are on the look-out. The question naturally suggested by all the present signs of Germany's commercial energy, and the high standard which her industries have set, is whether a *German* danger does not exist.

Explanations for Germany's imposing advance are plentiful in current literature. The good things that especially appeal to one in German life are probably all contributing in a complex way to the present prosperity; but long training and hard work tell most of all, and these characteristics came from a great past. The commercial power which Germany exercised in the Hansa times, did not entirely die out. The merchant houses of Hamburg, Bremen, and Lübeck, and the bankers of the inland towns, have, for centuries, kept up their traditions and remained in touch with the rest of the world. The closer union of German States into a peaceful and well governed empire was needed further to encourage the business enterprise and energy which was lying dormant. First therefore comes the merchant; then the engineer. The business of the future will probably depend more and more upon the engineer. As education becomes more general and theory more exact, the production of new articles of commerce will depend to an increasing extent upon engineering knowledge. All the problems which come up in railroading, mining, and factory operation will require still better engineering for their solution as the number of applicable inventions increases. Germany is especially strong on the engineering side of business. As German firms are in the habit of taking exclusive contracts, their staffs for tenders and construction are large. A manufacturer takes the responsibility for a whole plant, consisting of the most varied elements. Consulting engineers are not numerous in Germany.

There is no question as to the high grade of American engineering. Its boldness too, its ingeniousness, and practicalness, have been among the most characteristic phenomena of our development. American engineers have even won some of their best laurels under the trying conditions of European practice. But these flattering reflections should not blind us to the recognition that much waste of money, danger to life, and misuse of material, might have been avoided if sound training were more widespread among us, and men with at least rudimentary engineering education more plentiful. Our incomparable successes with empirical methods are still leading us into the temptation of relying on experience, and being merely "practical."

America has long led the world in the production of articles in which the interchangeability of parts and ingenious arrangements of mechanical details, combined with solidity, cheapness, and elegance of form are characteristic. The sewing machine, typewriter, and cash register are, perhaps, the best instances. Now it is probable that our factories will always have a fair part of the world's business in such articles. Our marked ingenuity will provide for improvement and novelty. But the last decade, especially, has shown us that the persistence of scientific theoretical workers can produce articles of commerce which can never be evolved by the brightest workman. For instance: the Welsbach mantle and other improvements in lighting have opened up branches which hardly could have developed from previous methods. Financial rewards for research are illustrated most strikingly perhaps by chemical products such as medicines, disinfectants, dyes, and photographic supplies. The German chemical industries are notably progressive and successful. The 143 chemical companies of the Empire, with a working capital of $158,000,000 returned last year an average profit of 9.37 per cent.

If, therefore, the technicist, the engineer, and the laboratory are to become more and more the dominating forces in industrial expansion, educational training becomes, even from a purely commercial standpoint, more essential than ever. Moltke's reputed saying that the Prussian school-master won the battle of Sadowa is still more applicable to the peaceful battles of trade. The great hope of the United States in industry as well as in government, is education. We depend upon it even more than does Germany or England, because we have an ignorant colored, and immigrant, population to deal with. There are now about as many people of the Greco-Latin, Slav, and other "feminine" races (to use Bismarck's expression) in the United States as the total of foreign-born inhabitants half a century ago. The strength of "masculine" Germanic influence cannot remain unaffected by this increasing element.

If we are to obtain any help from a study of Germany, as regards education, we must study the spirit of it and not merely the forms of its organization. The university methods are so generally known as to make any extended mention of these deep well-springs of scientific attainment unnecessary. It is worth while noting that some of the best men in the German industries today, come directly from the universities, and have no technical-school training. That productive scholarship on the part of the professors is immensely helped by leaving much instruction to the *Privatdocenten*, (tutors) is, no doubt, gradually being recognized by American educators.

The ten technical universities of the Empire, (called technical high-schools), enrolling over 17,000 students, are in close touch with, and a great help to, the industries. In several cases they cultivate special branches with regard to local interests. For instance, the school in Dresden, being near a great textile district, has a course for the technics of dyeing. The Aix-la-Chapelle school being so near the coal-fields and iron-works, has especially good courses in mining and metallurgy. Danzig includes marine engineering, of course, though Berlin already stands very high in that department. Karlsruhe has a forestry department; and Munich, an agricultural course.

The latest of these great institutes was opened only a year ago at Danzig. In conversation with some German professors I gained the impression that they had great respect for the American institutes of technology, and had in some cases made use of the superior arrangements of our laboratories as arguments in getting appropriations for the improvement of their own laboratories. Graduates of the best technical institutes in the United States, as seen in the industries, make, as a rule, quite as good an all-round impression as their German *confrères.* The former are likely to be more generally well informed and more flexible in their adaptability to a variety of work. A comparative novelty even for Germany is the commercial "high-school," a high-class business institute for instruction in finance, trade, and the business side of industry. The very latest advance in this direction is the *Handels-Hochschule,* commercial "high school," (remembering that this word is equivalent to our "college" or "institute") to be opened next Autumn under the auspices of the Corporation of Berlin merchants. It will receive only those who have had their years of apprenticeship in actual business and who are able to pass the examinations of the "one year service army volunteer." This is the first institute of its kind in Germany at least, to be the independent creation of such a body. The social side of German college and institute life is less healthful than that of America, although nothing in it compares with the occasional unmanly cruelty of our hazing.

It is not, however, so much in these two highest categories of education that we are likely to be surprised in our German observations, but rather in the bewildering list of middle and lower schools. The most wonderful thing about these is their ingenious adaptability to all hours of the day, to all ages, occupations, and grades of preparation. There are for instance scattered through Germany a number of private technical institutes (called *Technicum*) for those whose preparation does not fit them for higher engineering schools; especially for cases in which the earlier years had to be passed in shop work for self-support. Then, too, the cities are establishing new "technical middle-schools." It is everywhere evident that the Germans are no longer satisfied with a few hundreds of famous scholars, a few thousands of professional men—and then a drop almost down to the "three Rs." They are wisely grading off their material. They have many different standards as to what constitutes an educated man. Then they try for ninety-nine per cent efficiency under whatever standard the subject may properly belong. Even housemaids, butlers, and chimney-sweeps may receive in special schools all the correct fundamental preparation for their humble careers. The fact that a boy or girl has left the common schools and taken employment, is by no means an indication that the school days are over; on the contrary, the day's occupation creates interest for the evening courses in the "continuation" schools. In some of the schools charges are made, others are free. Some are supported by the State, some by the city, others by employers' guilds in various branches of business; and others by private funds. Some of the schools receive support from all these sources.

Public libraries offering as they do such a possibility for self-education are by no means as numerous or as well equipped in Germany as they were in many of our States even over a decade ago. Our weekly papers and monthly magazines are also, as the best informed Germans admit, far greater in number, more varied and, as a rule, more interesting than their own. The American periodicals being more widely purchased and read, are able to command a better class of contributors.

There is one great trend, however, that runs through all branches of educational life in Germany and which, according to my observation, explains the efficiency of the German system better than does the existence of this or that kind of school*; I refer to thoroughness of training in the rudiments. We may have in our country many ad-

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* The variety of opportunities for education will be more apparent if we glance, for instance, at the actual list of Berlin students in the winter of 1903-4.

(a) The Royal University	7,154	Students
(thirteen per cent. of all non-German students were Americans.)		
(b) The Technical Institute	4,157	"
(c) Mining Academy; Agricultural Institute; Veterinary College; Oriental Language Seminary	2,000	"
(d) Gymnasia, and others, corresponding to our higher grammar, and high, schools and lowest college classes	23,302	Pupils
(e) Common schools	222,472	"
(f) Private lower schools	16,432	"
(g) 4 Municipal night institutes	1,083	"
13 " " continuation schools	16,420	"
(among these latter 2,006 business, and 6,981 hand trade, apprentices.) These schools teach German, English, French, machine drawing, lettering, stenography, typewriting, commercial correspondence, bookkeeping and allied branches, sewing-machine work, machine embroidery, tailoring, mending, ironing, cooking, etc.		
(h) Various schools; for deaf and dumb, blind, orphans, etc.; also elementary training for Royal Theatre	892	"
(i) Two Municipal night trade schools including day courses for painters, cabinet-makers, modellers in clay and wax, electro-wiremen, etc.	4,979	"
(j) Builders trade	255	"
(k) Weaving school (101 *day* pupils and 239 *Sundays* and evenings)	239	"
(l) Cabinet-makers (1,028 being apprentices)	1,385	"
(m) Specialist schools—for masons, carpenters, saddlers, painters, chimney-sweeps (79 pupils), barbers and hairdressers (540 pupils), glaziers, smiths, basket-makers, book binders, printers, gardeners, photographers, tailors, potters, plumbers, paper-hangers, wagon-makers, etc.	4,903	"
(n) Schools supported by guilds and associations, as, for instance, 6 commercial night schools established by the Corporation of Berlin Merchants; also schools supported by bakers, and coopers	6,084	"
(o) Private institutions for technics, college and military preparation, etc., including schools for house servants, tailors, housekeeping, womens' handiwork, sewing, etc.	4,359	"
Total	316,116	

The above does not include the kindergarten, or schools of art and music.

vanced ideas as to gaining the pupil's attention and interest, leading by love instead of the rod, and increasing powers of observation; but the cold-blooded German schoolmaster seems to succeed in doing such an immense amount of drilling, especially in mathematics and languages, that these branches become useable and are not soon forgotten. Languages as taught in our schools seem to have been considered too much from a literary and analytical standpoint, and it is a rare thing for even a college graduate who has had frequent examinations in French and German to be able to speak a word or understand a paper in these languages until he has learned them over again in Europe. In fact, the German clerks, stenographers, and business men, in general, use their *mother tongue* more grammatically than do Americans under analogous conditions. Even our college boys and school teachers frequently show a lamentable carelessness in this regard. Notwithstanding the high rank of our advanced mathematicians and astronomers, mathematics seem to be much more of a stumbling block for us as a nation than for the Europeans. They require immense training rather than great ability. The continued practice, repetition, drill in everything is, therefore, to my mind, first of all, the key-note of German education.

Another element which makes for efficiency in German life and, of course, plays a great rôle in the school routine, is discipline. The average German is certainly not more mentally alert or convincing than an American in an analogous position. But the national attitude of mind is friendly to order, clearness, organization and precision. Germans are taught respect for existing arrangements; the subordination of the member to the body; regard for duly constituted authority as designated in rank and title. This comes somewhat from military *régime*; but long before Germany had a well organized army it had the well organized home. The child's obedience of its father came first of all. The child is not only punished for disobedience, but is trained in a certain code of manners and correctness of formality which, under similar conditions, our children are expected to pick up for themselves. Such training may not prevent the subject from becoming a boor, but it will lay the foundation for system; obedience to the orders of the next above, obedience to the laws. This produces a normal type. It may interfere with individuality, but it does not seem to hurt the intellect or weaken the energies. Carried too far it throttles that daring resourcefulness and independence of decision which is so characteristic of American business men, and which may save a situation where correct procedure means catastrophe. With us the initiative of the individual in the organization is largely depended upon; with the Germans it is the strength of the machine. With us an appeal to the individual may accomplish wonders. While the *esprit de corps* of American technical staffs, in many of the large firms, is infinitely better than that which you would find in Europe, and while the American business man may be something of an engineer (and a good engineer in America is frequently very much of a business man), and while with these qualities the American can make up for what he lacks in the way of order in his nature, there are many points in industrial organization where a large supply of discipline makes toward efficiency. There may be in Germany a lack of friendly contact between the man and his superior. There is, perhaps, too little personal feeling and too much coldness in everyday business dealings. On the other hand, there seems to be sometimes in America a certain neglect of precision on the part of the officer toward those under him, and a tendency to avoid giving strict orders. Advice and suggestion are often, perhaps wisely, made to take the place of instruction and reprimand. How far we could learn from Germany in tightening the reins a little, is a delicate question.

Germans are however always impressed by the fine appearance of an American industrial staff. The officers, department heads, and engineers make a very imposing group. This is perhaps due to the breadth of our experience, or education, and to the fact that the officers of American companies treat their assistants with that consideration above mentioned, which is not the rule in Germany. Furthermore, a German concern has very few highly paid men, but these work as rapidly, as efficiently, and quite as much, I think, as their American *confrères*. The German may, after all, be right in saying that if a poor country like his own is to have any great result from its industries, there is "no time for making compliments." It is a hard grind in which everybody must be exacting and get as much as he can from those under him. The Germans are used to looking truths in the face. The employees of great firms are mostly free from illusions. I think their rather hopeless outlook is going to be dissipated to a certain extent in a few years, when the idea of sport has taken hold of the nation to a greater extent. The very disturbing pause of two hours in the middle of the day during which no other "sport" than eating, drinking, and sleeping can be indulged in, will, in the course of time, give way to the American system. Certain tendencies to irritability and depression will then succumb to the influence of fresh air and exercise. Even fresh air, however, can become a serious disturber of industriousness if indulged in too much. Some observers think that we have a tendency occasionally to drop the end of the day or week from our business calendar in a way that German business at least would not stand, no matter how much good, theoretically, the recreation might accomplish.

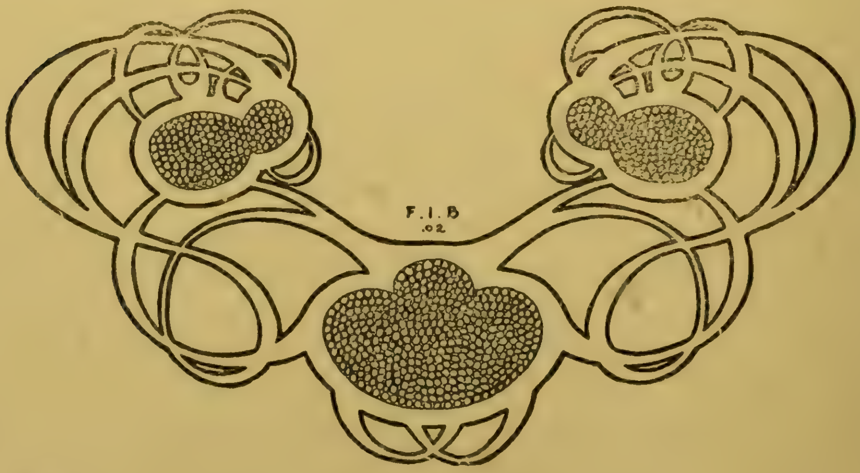
Not a little of the credit for German industrial success and power is due to good government at home. The engineer is becoming every year a more important factor in the life of the city and the country. Germany's public technical achievements are worth ten times the study we give them. The men who design and carry out their public works are unassuming experts; masters of their specialties; comparatively little in the public eye; contented with small remuneration. Only a very limited use is made by the daily press of personal notes, portraits and interviews. It thus happens that a German engineer may be exceedingly clever and productive without becoming known outside of his profession. And even the technical press is inclined to be very impersonal. Our national eagerness for personalities, our amusing fondness for "throwing bouquets," probably does have at least the merit of securing for a deserving man a greater breadth of opportunity and a higher general standing than unadvertised efforts alone could bring. In the agitation regarding governmental and municipal ownership of public utilities which, from now on, will certainly be a feature of our political life, the study of German, and not merely English, experience, though not necessarily applicable to our own conditions, will be illuminating.

The statement that American railway managers could learn anything from the Germans, will seem like pure heresy. The apparently higher regard for the value of human lives in Germany is dominant in their technical practice. Even some of their arrangements of minor importance might possibly be adopted by us without much discussion; for instance, the use of slot machines for the sale of city and suburban tickets, and for the sale of platform tickets (2½ cents). The discretionary powers given gate-keepers in some of our stations, and in some cases the positive rules against the admission of those accompanying travelers to the train, constitute an annoyance which is incompatible with the liberality of our railways in other particulars. Of course, unfair discrimination in rates and private freight-car abuses do not exist under the German Government system. The Germans consider Government ownership and operation of the railways, while salutary for their own country, entirely unadapted to our present national spirit of order and discipline.

As for municipal ownership, the large socialistic element in Germany has for years worked in this direction. A good basis for municipal ownership existed in the excellent and business-like management of the cities. But despite this fact it is private capital which has within the last few years revolutionized traffic and opened up new districts for settlement. Out of the 2,370 miles of electric roads in Germany, only about 400 miles, or 17 per cent, belong to the municipalities, counties, or States; and some of these even are operated by private companies. Out of 140 centres of electric transportation, only 31, or 22 per cent, have, even in part, municipal roads, and many of the centres included in this list have *more private* than city lines. Hamburg and Leipzig have no municipal lines in operation whatever; Berlin has about ten (unprofitable) miles and is soon to build a few more. When, according to contract, the opportunity came for the city to take over the very successful and highly modernized light and power plants, it failed so to do. The German cities have properly guarded the common interests when awarding franchises and, as a rule, they consider that the present large annual payments to the city made by private corporations, represent as much net profit as could accrue to the citizens on any municipal-ownership basis.

The postal service in Germany is far more satisfactory and reliable than our own. A former postmaster-general, eager to improve his system, and unable to get sufficient capital for buildings, resorted to the idea of enlisting private capital and making long-term contracts of rental. The Government has also built liberally and, in some cases, almost lavishly. The postal department, including the telegraphs, now turns in to the Imperial treasury a net surplus of over $16,000,000 annually. Now that an American postmaster has studied European methods, it is to be hoped that those upon whom he depends for appropriations may be brought to appreciate how much enlarged offices, increased personnel, and new conveniences are needed to serve our rapidly increasing traffic. The German telegraph service, operated entirely by the postal administration, is exceedingly reliable. Ten words, not including the address and signature, can be sent anywhere within the Empire, that is, a maximum distance of about 1,000 miles, for 12½ cents.

There is nothing, however, in Germany to approach the system and rapidity which has developed along with the volume of our Stock Exchange business. The Clearing House, brokers' boards, quotation and news tickers, telephone arrangements and, in fact, the whole paraphernalia connected with Wall Street is, to the European, a wonderful combination of business cleverness and technical skill. The adaptability of our telegraph and telephone systems to meet special demands could probably never keep pace with the public needs, if placed under Government management. The special terminal facilities and rates which our chief telephone company arranges for firms with long-distance connections, the private wires, the telephoning and telegraphing of election news, etc., are not concessions wrought from an unwilling management, but ingenious ways of pleasing the public and, at the same time, extending the usefulness of our technical means of communication. In Germany the telephone service is also in the hands of the Government. It is managed conscientiously, even liberally, and is really being improved continually; but the machinery of even so surpassingly good a Government does not seem to be adapted to the extension of such a service, in which one must really feel the public pulse. There are not quite four times as many telephones in the Empire as there are in Manhattan and the Bronx. There are few public booths, and no telephones in the hotel rooms which can communicate with the city lines. The telephones used for internal communication between the rooms of an office building are separate from those which connect with the outside world. To one returning from a long residence abroad, the effect which the telephone has had in the last decade in changing the physiognomy of American business and social life is more marked and wonderful than any other single feature of difference between the Old World and the New.



ELECTRIC TRACTION BY ALTERNATING CURRENTS.

By Louis Bell.

Dr. Bell's topic is the most important in electrical engineering at the present time. The heavy installation decided upon by the New Haven road accentuates the interest of this discussion by one of our most instructive modern writers.—The Editors.

BY far the most interesting development in electric traction during the past two years has been the introduction of the alternating-current motor, both in America and Europe. Its appearance was nearly simultaneous in the United States, Italy, and Germany, by methods closely similar. The publication of Dr. Finzi's experiments served to stir up the others who had been working on the problem, and to do justice to the American contingent, its work was probably ahead of the rest. The immediate result has been the equipment of perhaps a dozen roads of the smaller sort, and what is far more sensational, the ordering of alternating current locomotives on a large scale by the New York, New Haven and Hartford Railroad Company. It is this last move that has stirred up the most active discussion in engineering circles.

Now the fundamental question to be asked in the premises is this: "Why should any engineer prefer an alternating-current motor for electric traction when he already has exceedingly good direct-current motors?" And the answer is an exceedingly simple one. Engineers do not prefer the alternating-current motor as such, but because by its means it becomes easy to do certain things which are practically out of the question so long as one adheres to direct current.

The fundamental advantage of alternating current for nearly all purposes lies in the fact that energy in such form can be changed in voltage to any required extent by very simple apparatus at very high efficiency. The alternating-current transformer costs considerably less than half as much as any form of electric generator, and transforms the energy received into energy of different voltage, at a loss of only two to three per cent. Hence, by carrying about a piece of apparatus neither very costly nor very heavy, one can receive from the line energy at very high voltage and deliver it to the motor at whatever lower voltage may be required. The alternating-current motor in itself is not especially suitable for high voltage, but the combination of transformer and motor can not only work on a high-voltage circuit but on the motor side can be operated with as wide a range of voltage as may seem desirable for the purpose of regulation.

Since the amount of copper required to transmit, let us say, the energy for a car over a given distance, varies inversely as the square of the working voltage, the loss remaining the same, it is clear that to deliver power to a car at 2,500 volts requires only one twenty-fifth as much copper as at 500 volts. In other words, excluding some minor considerations, there is an enormous gain in the cost of delivering energy to the cars if one works at the high voltage used with the alternating-current system. All this has been long understood, and the standard method of working long electric roads today is to distribute the energy at high voltage over the system, and then, since the motors themselves are for direct current, to transform the transmitted energy to direct current and to distribute this to the working conductors from which the motors are fed.

It will at once be seen that this scheme requires two complete distributing systems over practically the whole extent of the road—one to distribute energy at low voltage to the motors, the other to provide at high voltage the energy for feeding the first. The change from high-voltage alternating current to low-voltage direct current is accomplished first by reducing the former through transformers to a voltage even lower than that of the direct current required, and second by changing from alternating to direct current via a rotary converter, which is rather more expensive than an ordinary dynamo and like it requires continuous attendance.

The series of energy transformations in a typical electric-railway case by the two methods respectively is as follows. Present system:—Generator—high-voltage line—reducing transformers—rotary converter—low-voltage line—motor. Alternating system:—Generator, high-voltage line, reducing transformer (on car)—motor. This series omits the two steps which in the former are particularly serious in cost and in loss of energy. The saving in energy alone would in the ordinary case be some 20 or 25 per cent. It needs no argument, therefore, to show that such a change would be in and of itself extremely desirable.

In addition the supply of energy at high voltage from the working contact conductors very greatly simplifies the collection of current by the contact devices. At the customary working voltage of about 600, the current necessary to drive a modern interurban or suburban train amounts to several hundred amperes, a quantity which it is extremely difficult to obtain from an overhead trolley wire without very troublesome sparking and burning at the contacts. Hence many roads have been driven to the use of the third rail, which is a continual source of danger both to operation and to life, and which is extremely difficult to insulate adequately. At high voltage the necessary current proportionately decreases so that in the Zossen tests of a couple of years ago the heavy cars requiring at the higher speeds an input of 2,000 horse power, received their energy from three slender overhead wires each about the size of a lead pencil. So far as simplicity, efficiency, and cost of the conducting system is concerned, there is everything to gain and nothing to lose in using alternating current.

The rail return circuit undoubtedly has considerably lower virtual conductivity for alternating than for direct current, but this difference is more than offset by the fact that with alternating currents the electrolysis—sometimes very formidable with direct current—is of small moment.

Under these conditions it is not surprising that alternating-current traction has been vigorously pushed, and the sole reason for its relatively small development up to the present time must be sought in the difficulty of designing proper motors. To be sure, there have been a number of successful three-phase roads abroad using induction motors on the cars,. of which the best known is the Valtellina line. The fact that a three-phase line requires at least two working conductors has been a serious objection in the eyes of American engineers, mindful of the exasperating early experience with direct-current double-trolley lines. Unquestionably, in urban work with its many crossings, a double-trolley system is a nuisance; but on long interurban lines it is by no means difficult to manage. A more valid reason for wishing to dodge three-phase motors for traction is that they have but a single economical speed—that near synchronism. Speed regulation can be obtained by the use of rheostats on the same terms that are familiar in the rheostatic control of an ordinary direct-current railway motor, but in recent years this has been almost entirely superseded by the more economical series-parallel control, for which no proper equivalent is available in using induction motors. The so-called "cascade" arrangement of induction motors is far inferior to the regular series-parallel connection.

For a general solution of the alternating-current traction problem, then, it has seemed best to turn away, temporarily at least, from the otherwise very attractive induction motor and to take recourse to motor systems capable of being operated from a single alternating-current working conductor. One such system which cannot be passed over without serious consideration is that brought forward some years ago by H. W. Leonard and since somewhat developed experimentally abroad. It consists of a single-phase high-voltage circuit for the working conductor, feeding a motor-generator or rotary converter on the locomotive, which is in turn provided with motors governed by Mr. Leonard's beautiful regulating system. The scheme gives a far more perfect and delicate speed control than any other yet devised, and an efficiency high compared with that of the usual complicated plan of distribution. It is, however, open to the objection that the equipment required cannot be stowed away under a car, and gives considerable weight to be carried. If the very ingenious "permutator" recently developed abroad should meet the hopes of its friends, the weight situation would be very greatly relieved, and the fact is that for the heavy railway work in which locomotives are desirable the Leonard system has some extremely strong points which it is not the part of wisdom to overlook.

But for the ordinary routine work of electric railways it has been necessary to turn to an entirely different type of machine—the single-phase commutating motor. This machine is based on the simple fact that a series-wound direct-current motor does not change its direction of rotation if the current through it is reversed, but only if the relative direction in armature and field is reversed. Hence such a motor will work on a circuit in which the current periodically reverses direction if the conditions are not too severe. The requirements for success are lamination of the field magnet as well as the armature, in order to prevent great loss of energy from eddy currents; very low inductance, so as to allow the passage of heavy alternating currents without causing serious inductive troubles in the system; and finally, extraordinary care in the design of the commutator to prevent destructive sparking.

The first requirement is easily met, at the cost of considerable expense but at a gain in the weight of the motor owing to the use of better iron more judiciously distributed.

The second is met, first by very tactful design of the motor windings for low inductance, the result being a large and powerful armature in a field with relatively simple winding; and next, by the use of so-called compensating coils cross-magnetizing the armature and greatly reducing the virtual inductance. These are connected in various ways, but the effect is always to oppose by a reverse magnetomotive force those components of magnetization that would cause troublesome inductance. It is needless here to go into the details of the various forms taken by the compensating winding, and it is sufficient to state that they have proved highly effective.

Finally, the commutation of an alternating-current is a very troublesome matter, owing to the fact that there is generally no instant at which commutation can occur without either breaking a considerable current or leaving considerable electro-motive force between bars. The heavy inductive effects tend strongly to produce sparking or even flashing over the commutator surface, and it is not putting the case too strongly to say that successful commutation is the vital point in developing a successful single-phase railway motor. It is impossible to say, at present writing, in how far this difficulty has been or can be remedied.

By means of a complicated commutator with low voltage per bar and auxiliary resistance to check the rush of current when two bars are short circuited, the tendency to sparking can certainly be much reduced. The question of output, however, enters the problem in a somewhat troublesome manner. An arc-lighting dynamo for instance may operate beautifully at 5,000 volts with say 6 amperes of current. Doubling the current would greatly increase the trouble from sparking, even with the proper changes in the windings, and the difficulty would be enormously enhanced if the current output were planned for 100 amperes. Exactly the same sort of difficulty is met in designing the commutation of an alternating-current motor, and the complete success of a 15-horse-power machine for given voltage is no guarantee whatever of possible results in a 150-horse-power motor. The limitations thus encountered are merely a question of fact about which it does no good whatever to theorize.

At some point in the continued increase of output, forbidding difficulties are to be anticipated; but whether this point is above or below the requirements of electric railroading remains to be seen.

The single-phase alternating-current motor has two inherent difficulties which no amount of finesse can entirely circumvent. In the first place, there is necessarily a loss from hysteresis in the iron and from residual eddy currents that renders the machine clearly less efficient than a direct-current motor of the same output, by an amount that may be roughly estimated at between 5 and 10 per cent. Second, owing to the fact that the energy supply derived from a simple alternating-current is intermittent, the output of such a motor is, other things being equal, less than that of a direct-current motor of the same effective weight of material, by 25 per cent, more or less. As single-phase motors are practically built, the great care in design and the high grade of magnetic material used tend to lessen the differences both of efficiency and of weight here referred to, the inherent disadvantages being thereby transferred to the cost.

As regards speed regulation, the alternating-current motor has rather the advantage, since by using a transformer capable of supplying various secondary voltages the motors can be worked over a wide range of speed without recourse to rheostatic control. The ordinary series-parallel control has two economical speeds and has to waste energy in resistances at all others. It should be noted, however, that this difference is not practically of much importance, the resistances being used as little as possible, merely to check too sharp changes in speed.

As may be judged from the principles of the alternating-current commutating motor, it can be used upon a direct-current circuit of proper voltage with good results. This advantage has been made much of in recent discussions—rather more, in fact, than can fairly be justified. It is quite true that the motor works easily on either kind of circuit, but the specialization of the structure for alternating current is not altogether advantageous for direct-current working, and the duplicate use produces enormous complication in the wiring and controlling devices, including even the current collectors, of which one must be for high voltage and the other for low. Certain parts of the controlling apparatus may be made to serve in both cases.

The fact is that while the duplicate use is entirely feasible, it is not exactly simple and convenient, so that most engineers are disposed to look upon it somewhat dubiously, as a convenient stop-gap rather than a measure of permanent value.

In summing up the alternating-current traction situation one sees, first, that the new method has its chief and commanding advantage in the greatly simplified distribution—an advantage that rises in importance with every extension of electric traction into wider fields. Extension of electric traction to trunk-line and general railway work may be regarded as practically out of the question with the so-called "standard" direct-current methods. Higher voltage on the working conductors is imperative—so much higher as practically to preclude the use of direct current up to the car. The kind of transforming apparatus and motors used on the cars are of far less importance, especially in the big work just referred to for which electric locomotives would naturally be used.

In the commutating single-phase motor as now developed, one has a most interesting and ingenious machine, possessed of some very valuable properties, but still essentially untried upon the scale necessary to demonstrate its general value. The preliminary experiments have been promising, while on the other hand the difficulties are of a kind that do not fully disclose themselves in working on a small scale.

The large work with alternating-current locomotives to which the N. Y., N. H. & H. R. R. now stands committed will furnish a most valuable demonstration. If the locomotives now under construction come fully up to their requirements, the work of heavy electric traction is likely to be revolutionized. It does not follow that every electric-railway system will at once be converted to alternating-current practice, for it has not yet been demonstrated that the change would always be worth while. In fact, the manifest advantage of alternating current is essentially a matter of distribution, so that it varies with the relative importance of distribution in the problem considered. The alternating motor equipment is and is likely to remain under some disadvantage in the matter of first cost and maintenance, so that when the final balance is struck, it will be found in favor of alternating current when the element of distribution is above a certain magnitude, and the reverse when it is below that magnitude. Obviously it is not a case for hasty judgment but for deliberate consideration. And an important feature of the matter in its bearing on the future is that a gain quite sufficient to determine the use of alternating current in a new enterprise may be insufficient to justify a radical change in an equipment already in use and which represents a large investment. A similar situation has long existed in electric lighting. Alternating current is used for nearly all new work involving considerable distribution, while for work at short distances, and for extensions of existing direct-current networks, the older method is used—in the latter case sometimes very far beyond the point that would be advisable save for the large investments already made.

This much is certain—that alternating-current traction in some form is highly desirable for much of the future railway work; that it has already made progress enough to deserve serious consideration and to ensure future growth; and finally, that if the large experiments now under way turn out well, alternating-current motors will be pushed into very extensive use both in new work and in the re-equipment of systems in which direct-current traction has been forced beyond its economical limits.

THE SQUARE DEAL IN WORKS MANAGEMENT.

By O. M. Becker.

II. WHAT CAN BE DONE WITH THE SHOP.

In a preceding article, in our issue for January, Mr. Becker inaugurated the present series of papers with an introduction pointing out briefly the conditions which have developed in the manufacturing world with the use and growth of the factory system. He showed that far-seeing and successful managers everywhere were wakening to the necessity (and the direct commercial profit) of considering the welfare of their work people at least as carefully as that of their machines, and that out of this recognition was growing a new and hopeful movement in the adjustment of the relations between employer and employed. In the following paper he takes up, analytically and concretely, the feasible changes in the shop which will lead not only to increased product, but to lessened danger of friction and trouble with employees.—THE EDITORS.

TO such an extent has the "altruistic" spirit grown—the spirit of the "square deal" in the management of employees—that there is an increasing need for men and women qualified to undertake its concrete application in commercial and industrial establishments, just as experts are required for the direction of other branches of business.

In many of the larger producing, trading, and transporting plants, and not a few of the smaller ones, there is at least one person whose time is devoted wholly or in part to looking after the comfort and welfare of the other employees. In most such places this social secretary, welfare manager, or educational director, as he has been variously designated, conceals his real work behind some other presumed to be more conventionally associated with the business. In small establishments such a combination of duties is usually necessary from considerations of economy; and in some larger ones the same arrangement may be desirable. There is, however, a growing disposition to regard the social or welfare work—that is, the work of providing and maintaining decent and agreeable working conditions—not only as legitimate, but as essential, and therefore as an integral division of a business. Experts in all other departments of a business are not apologised for; why should an employer seek excuses for having an expert adviser in matters affecting the physical and social well-being of his people, and therefore the efficiency of his plant? Experience has shown that the American working man, indiscreetly independent as he is at times, is more likely to look with suspicion upon half-way advances made under the cloak of something else than upon an open and frankly avowed purpose to deal with him as he has a right to expect to be dealt with—to meet him as a man and not to regard him as a mere machine. The employer's honesty of purpose quickly manifests itself in the things he does and the people he sets to doing it. If extended in the right spirit—the moral, fair-minded spirit that characterizes the square deal—and not thrown *at* him as a sop, the American working man quickly meets the employer half-way, and more than half-way, with his co-operation.

Under such circumstances and under a director of broad sympathies, able and willing to rub elbows with the humblest of the workers and not above being one of them—a man or woman keenly appreciative of the tremendous possibilities ahead in such a work—a "Welfare Department" in a business acquires a standing in the eyes of the employees and makes it possible to restore in a measure the old-time personal touch between wage earner and wage payer. Mr. H. H. Vreeland, president of the New York City Railway Company, (the company that operates practically all the surface car lines in the metropolis), undoubtedly has the correct idea with respect to the method of bringing employer and employed into close relationship and incidentally giving them the best possible working conditions. He himself goes among his men, meets with them periodically, and therefore keeps in such close touch with them that there is no occasion for an intermediary except to carry out the details of his plans. The zealous loyalty of his employees attests the soundness of his policy. Where such a course is out of the question, the welfare department should have for its chief function that of intermediation. Its director will stand between the individual employees and the employer, and will represent him in his social relations to them. Its success will be measured absolutely by the extent to which it touches the lives of individuals and elicits responsiveness to that touch; and this in turn depends with equal absoluteness upon the personality of the director and the latitude allowed him. A welfare department organized as a machine and left to run itself with a director as operator, will come as near to a manifestation of the altruistic spirit as a punch press does, and will elicit about as much response. Only actual sympathy, honest purpose, and the real sense of human brotherhood can touch the responsive chord.

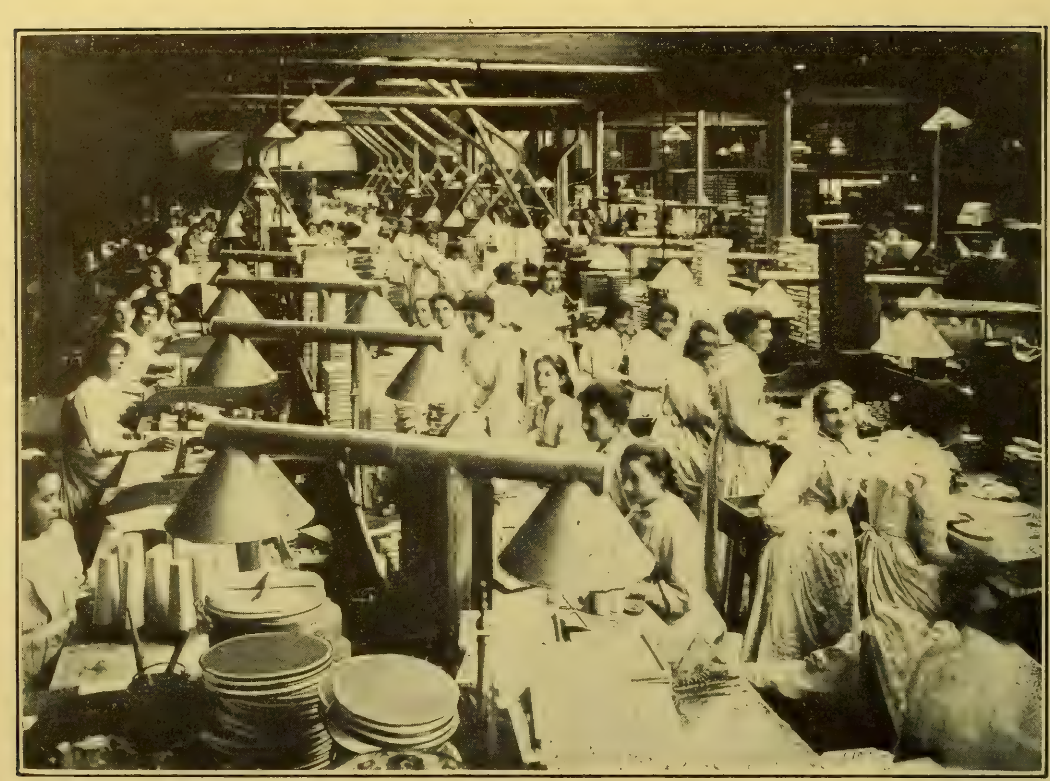
The question as to whether the head of a welfare department ought to devote his whole time to this work, or should be charged with other duties connected with the operation of the business, is not to be determined by a dictum. Where the number of employees is comparatively few, there would be small need for so much time devoted to welfare work alone, except perhaps at the time of its inaugural or organization. In such case the welfare man (or woman) undoubtedly should be an integral part of the business in other capacities also. The fact of being a part of the regular working force—that is, a worker *with* rather than *for* them—gives him a fine opportunity to gain the confidence of the other employees without which little good can be done outside of providing facilities for the observance of the decencies. In some of the largest establishments the same plan has been found to work best. Mr. Nazaro, of the Plymouth Cordage Co., is also head of the construction department, and believes firmly that this is the surest way to acquire a standing among the work people. In one of the large retail stores of Marshall Field & Co., of Chicago, what might be called the welfare activities are not systematized at all; but are watched in a general way by the assistant manager, Mr. Towsley. Nothing better could be desired in the way of *esprit de corps* and loyalty than is to be found among the employees in this great store. Nevertheless there would undoubtedly be greater opportunity for the intermediary of the employer to get into touch with and to be helpful to the individual employee if there were a definite organization with a responsible head, as in the case of the Plymouth Cordage Co. and a good many others, where the welfare director gives all his time to this work alone. One thing may be said with assurance: in any plant employing as many as, say, a thousand people, there will be enough work, if properly undertaken, to keep one person pretty busy, and frequently to require considerable assistance.

While it is difficult at times to draw a distinct line, the work of a welfare department naturally divides itself into two pretty well defined groups: those activities, or rather those conditions, making directly for the comfort and convenience of workers in the performance of their regular tasks; and those ministering to their physical, intellectual, social, and moral wants. The first group are necessarily closely connected with the equipment and operation of the business, and involve no particular co-operation on the part of employees further than proper use of the facilities provided for them. Under this category would be placed such items as proper heating, lighting, ventilation, sanitation, and cleanliness of buildings and premises; safety devices on machinery for the protection of operatives, and appliances for the removal of dust, gases, and waste that would cause discomfort or be dangerous to health; medical attention, at least

A MODERN AMERICAN MODIFICATION OF THE "GARDEN CITY" IDEA.
The plant of the B. F. Sturtevant Co., Hyde Park, Mass., illustrating the tendency to seek the suburbs where relatively cheap land, good air, and freedom from congestion can be secured.

to the extent of providing first-aid assistance in cases of injury or sudden illness, and retiring or rest rooms for women who may be temporarily indisposed; sanitary toilet and lavatory conveniences ministering to the decencies; opportunities for comfortable positions and the elimination of unnecessary exertion while at work and in going to and from it; decent lunching facilities; women overseers for female operatives; and improvement in physical surroundings of work rooms and premises.

So widespread has become the sense of responsibility in certain of these matters that few new shops are now erected or equipped without careful attention to the conditions that make for the best working environment, including the common decencies. In many recently built plants these things have been most carefully considered. In old shops, built and equipped before anything more than walls, floors, and suitable manufacturing machinery was thought important, there are likely to be practical difficulties in the way of making needed improvements. Of course, there will be instances where the conditions are so abominably bad that sane business considerations would dictate the disuse of the premises for work rooms. Usually, however, the case is by no means hopeless. It is possible by resorting to well-known expedients to work surprising transformations of very unpromising conditions. The only question usually involved in thus making the best of what is at hand by modernizing it as much as possible, is that of expense. However little attention to the safety of the operator may have been given in the designing of machinery and other shop equipment, it is quite possible to cover dangerous parts; to provide collectors and exhausts for dust, gas, or other waste; to supply suitable fire protection and escapes; to install sanitary conveniences; and to do many other things to protect the life or preserve the health of the work people.



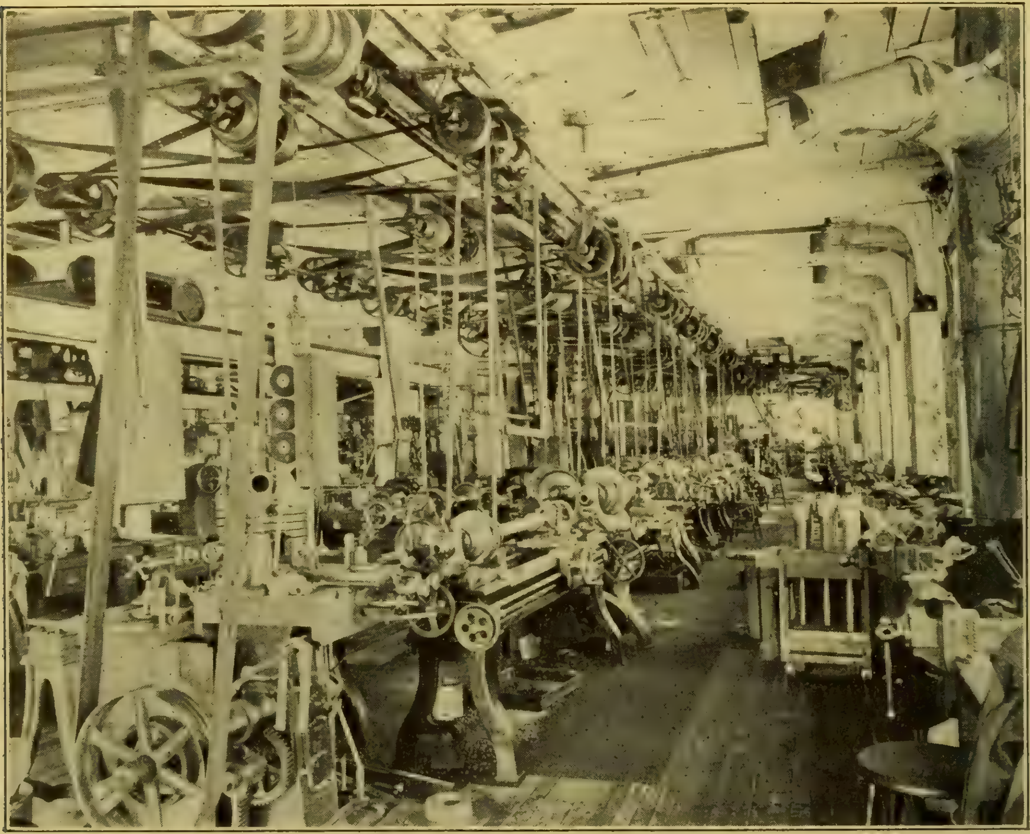
A WORKROOM FROM WHICH POSSIBLE OFFENSIVE ODORS ARE ENTIRELY REMOVED. The box factory of Cadbury Bros. Cocoa Works, Bourneville, England. The cheapest (and therefore most offensive) glue is used; but cowls placed over each work-table and connected with an exhaust system keep the air as unobjectionable as that in any ordinary shop.

In many States there are statutes specifying minimum requirements, sometimes lamentably low, with reference to the protection of employees in factories. Almost every year the minimum is raised; and it is gratifying that employers of labor, especially those of large interests, are inclined to accept gracefully all such legislation, and even to go far beyond the legal requirements. Unfortunately there are managers responsible for shamefully, even criminally, inadequate provisions for the protection of workmen against accidents; managers as yet unregenerate, to whom a dollar in hand looks very much bigger than a finger on hand—or even bigger than a life in jeopardy. The astonishing mental attitude of such men toward the sacredness of human life and the human person is typically illustrated by the remark of a certain superintendent when shown a new safety device. The appliance was designed to prevent the boy and girl operatives at certain machines having their fingers cut off—an accident that frequently happened. When informed of the cost of the device he jocularly remarked, "Hell! fingers don't cost us anything." Happily such men are no longer so numerous as formely in responsible positions. Given, the willingness to provide adequate protection against accidents and personal injuries, the question is likely to be asked, "What more can we do? Have we not fire escapes, enclosures for rapidly revolving wheels, and other protective devices?" Doubtless most shops and commercial plants observe the letter of the law in respect to the most obvious of these things—particularly when there is a rigid factory inspection. But there are a thousand and one things that necessarily escape the factory inspector, which are nevertheless dangerous to life, limb, or health. The remarkable frequency of small accidents in all sorts of plants must be attributed to the neglect of the management solely—barring possibly the few instances of absolute foolhardiness on the part of the injured after all possible precautions had been taken. Most of these accidents arise from neglect of little things that are easily remedied, if seen. And they *should* be seen. Possibly it would be outside the province of a welfare department to make all inspections of this sort; but undoubtedly there ought to be a close relation between the inspection and that department.

HOOD OVER BOILER FRONTS, REMOVING EXCESS OF HEAT AND BETTERING THE FIREMAN'S WORKING CONDITIONS.

Plant of B. F. Sturtevant Co., Hyde Park, Mass.

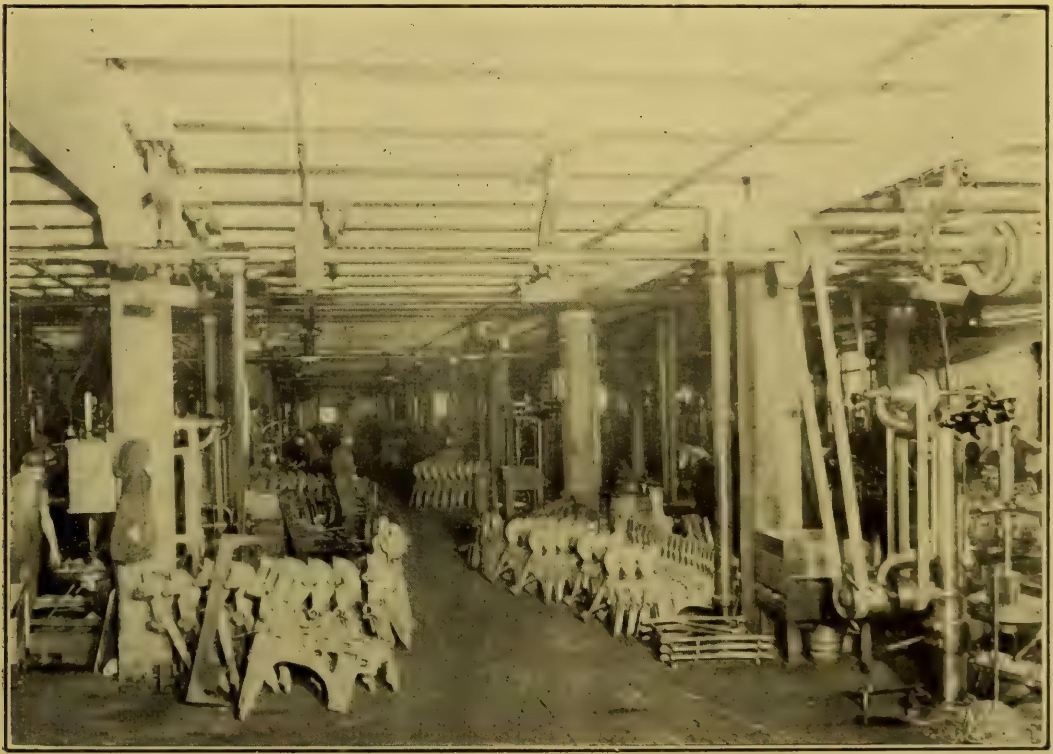
Automatic safety gates and stop clutches for elevators, covers for gears, and the like devices are universally required nowadays. But they are by no means universally kept in a state of efficiency or adequacy. Belts are not usually watched closely, nor always carefully laced or otherwise jointed; holes are allowed in floors; shafting is at times allowed to extend beyond bearings and to have dangerous projections to catch the clothing; belts within the range of the machine man's activity are often left without being cased; and a multitude of other equally insignificant omissions all contribute to swell the number of preventable accidents. It is not enough to say that most accidents result from the carelessness of the injured. There doubtless often is contributory negligence. But no machine or workroom can be said to be properly safeguarded until it is absolutely "fool-proof."



AN EXCELLENT RESULT SECURED IN SPITE OF UNFAVORABLE CONDITIONS OF SHOP CONSTRUCTION.

An old type of building, in which the walls and ceilings are kept whitewashed and a portion of each sash is glazed with ribbed glass. The light is uniformly diffused and cavernous corners are prevented. Note the stools for the use of workmen.
Courtesy of the Jones & Lamson Co.

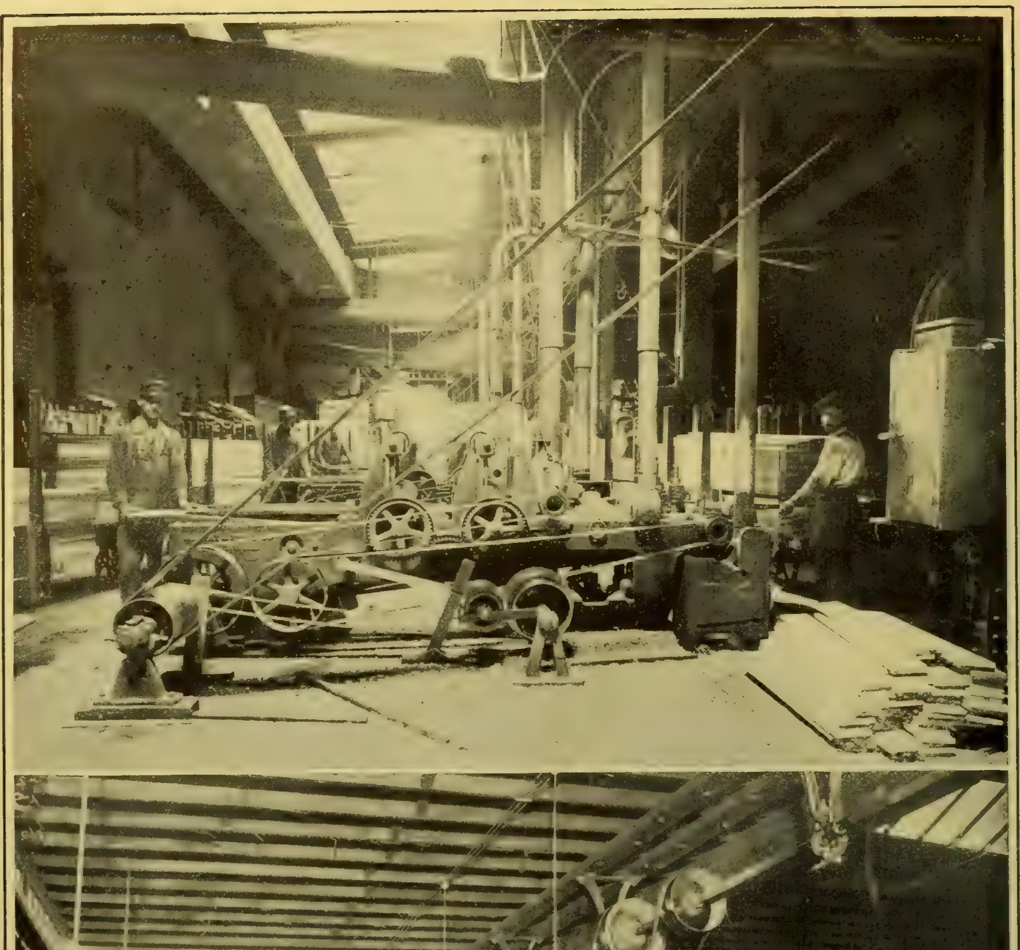
Very few of the old-time conditions that arose from a disregard for what are now well recognized principles of industrial and commercial practice but can be remedied wholly or in part without prohibitive expense. A badly lighted shop, for instance, might on first consideration be thought beyond improvement without a rebuilding of the walls, and an increase in window space. Such an increase may, indeed, be really necessary; usually, however, the simple expedient of keeping the existing windows clean and the walls and ceiling thoroughly whitewashed or, better still, painted a pleasing light color, will produce an astonishing difference in the lightness and cleanliness of a work room. Where high buildings mutually shut off light from each other, whitening the adjacent walls adds greatly to the interior illumination. If to these expedients be added that of using ribbed glass instead of the plain, in part or all of the window sashes, the change is really remarkable. The ribbed glass diffuses the light uniformly throughout the room and does away with that dim, cavernous appearance common in so many work rooms. Where the product requires accurate workmanship the necessity of thorough lighting is of course obvious. But in any case there is no valid reason why men or women should be asked to work in semi-darkness or by unsatisfactory artificial light when God's sunlight may be had so easily. Many a manager pays more in a year for artificial light than would pay for these suggested improvements and others besides.



WHAT A LITTLE WHITEWASHING WILL DO.

The conditions are not ideal—note the unlighted parts, and lack of wardrobe facilities indicated by clothing hanging from the pillars; but the white ceiling quite alters the place from its former conditions.

In the construction of new shops, where ground is not too valuable to permit of one-story buildings, the "saw-tooth" roof method of lighting is favored. In a shop of this construction practically all the light is taken from the north and is diffused by passing through ribbed glass, insuring uniform illumination and the absence of dark corners. There is an additional advantage in that the lighting is from above.



INSTANCES OF UNNECESSARILY BAD LIGHTING.

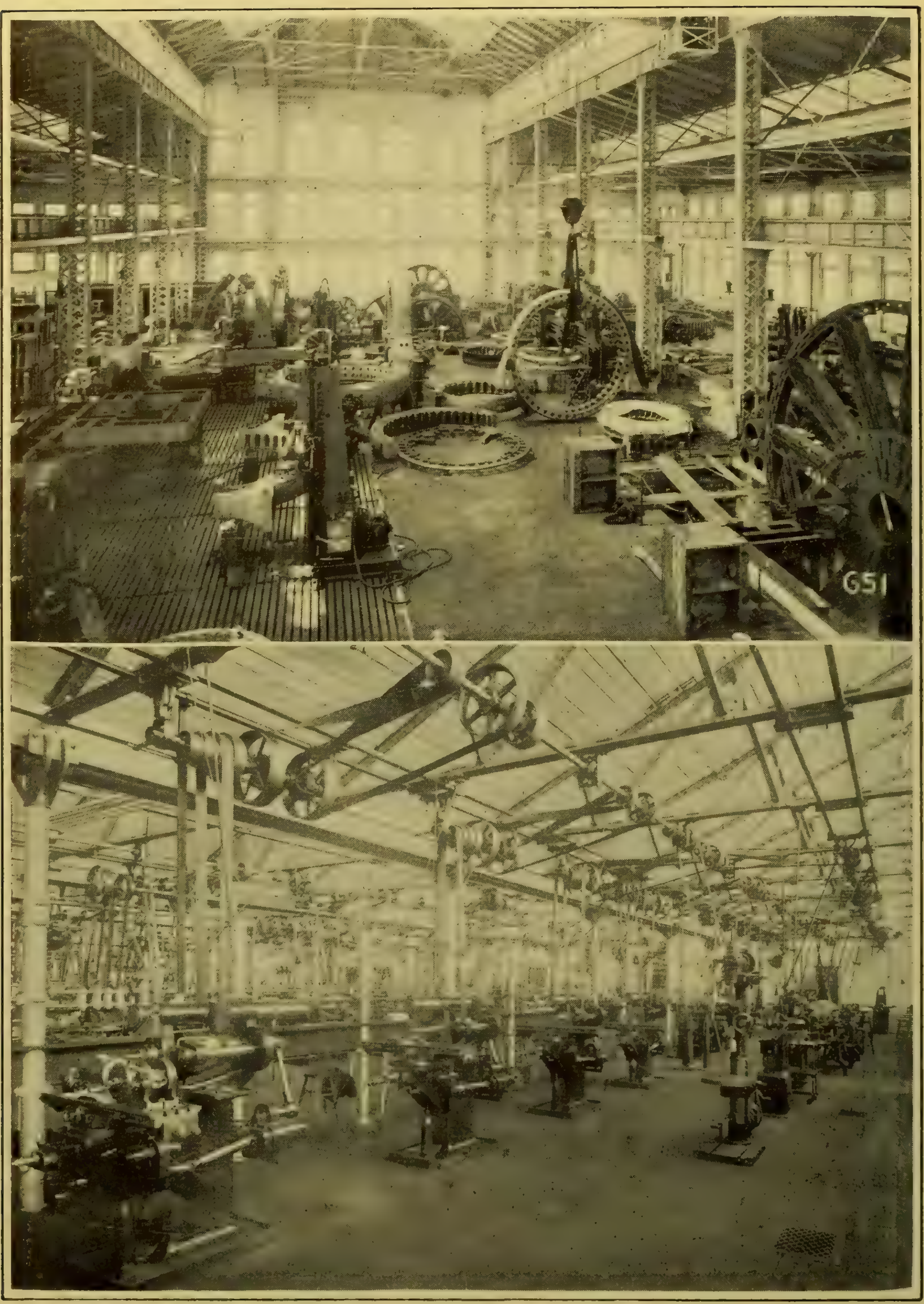
The work illustrated in the lower picture is not of a kind requiring great precision, but men should not be made to work in the semi-darkness enveloping those at the right of the view. And light could be admitted by the roof. The upper figure shows a common type of bad lighting—the center of the shop flooded, and the remaining portions in deep shadow.

The objection formerly made that buildings of this construction could not be made to drain the water properly, and were necessarily leaky, no longer holds good. One of the first of the large shops of such design in this country, that of the Weston Electrical Instrument Co., at Newark, N. J., solved the difficulty very easily. Similar shops are now common enough, though five years ago there was scarcely one in America, outside a few devoted to the textile industry.

WHAT THE MODERN FOUNDRY MAY BE—LIGHT, WELL WARMED IN WINTER, FREE FROM FUMES, AND SAFEGUARDED AGAINST ACCIDENTS.

The lighting is chiefly from the sides, and perhaps not quite so good as in some other shops shown. Deering Works, International Harvester Co., Chicago, Ill.

Another type of shop, peculiarly adapted to erecting or foundry work because of the crane service it permits, is also finding much favor—large buildings with broad central bays unbroken by ceilings, and side bays of several floors. The lighting is from the sides and from windows laid into the roof—the latter always of moulded glass, so as to diffuse the direct light. When ground is too costly to admit



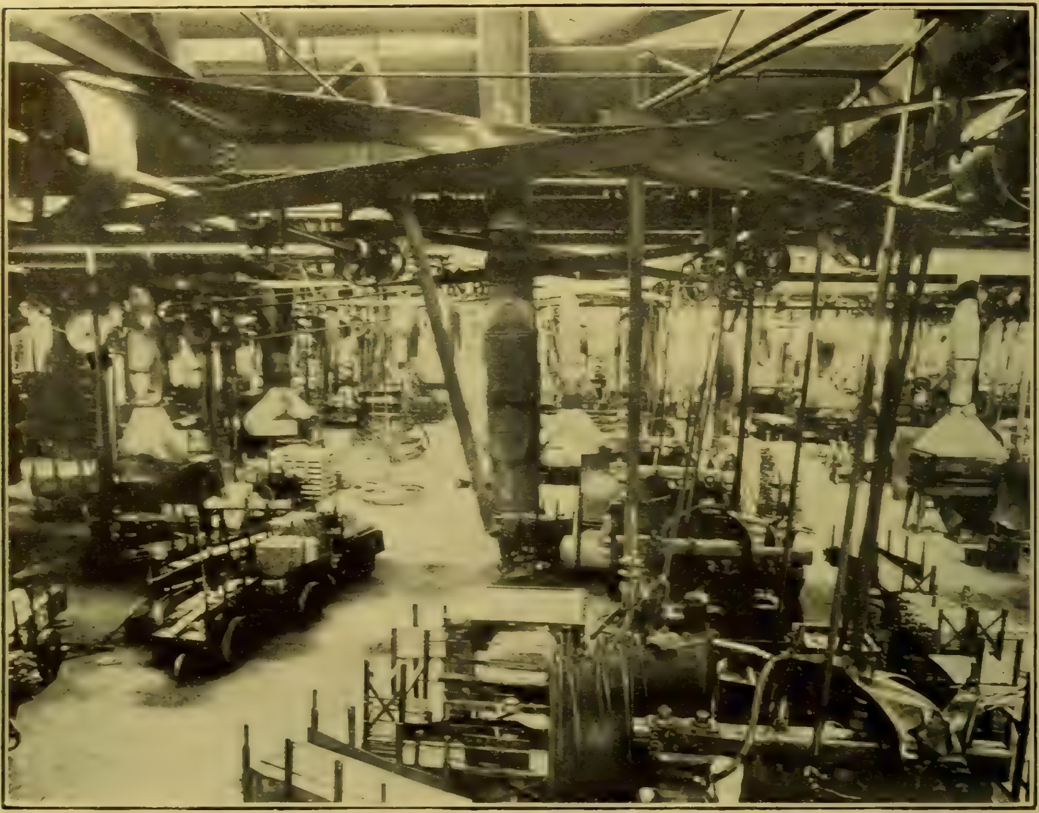
TWO EXAMPLES OF WELL DESIGNED AND WELL ARRANGED SHOPS.

The upper one shows a type of erecting shop which is more and more coming into favor—lighted from all sides and through the roof, and with all necessary arrangements for cleanliness and comfort. The view is taken in shop No. 3 of the Bullock Electric Mfg. Co. (Allis-Chalmers Co.), Cincinnati, O. The lower picture—almost aesthetic in its neatness and order, and yet wholly suggestive of the workshop—shows part of the works of the Weston Electrical Instrument Co., Newark, N. J.

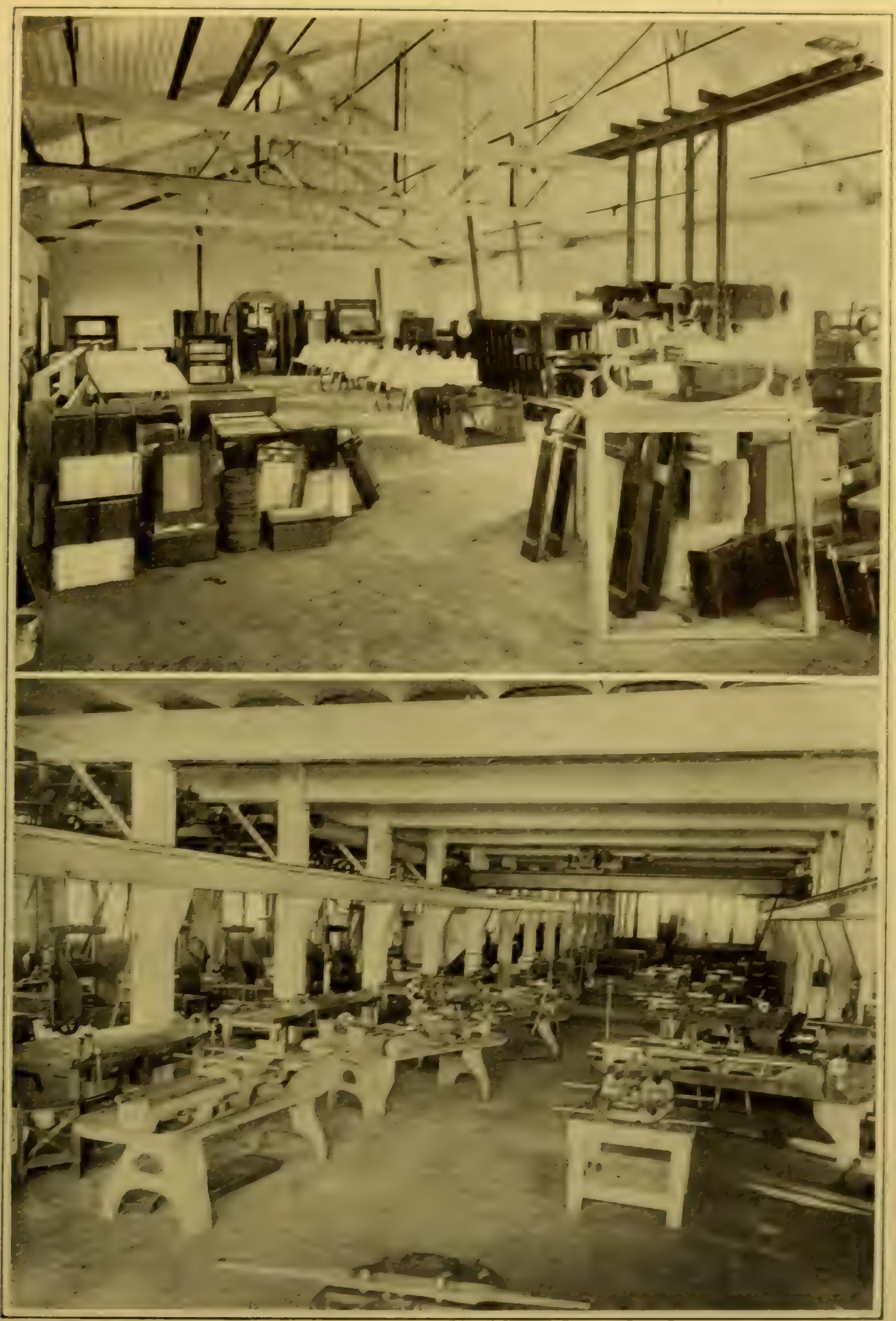
of anything but tall buildings, or where other considerations make such buildings desirable, modern steel construction makes it possible to build shops whose exterior surfaces are almost wholly devoted to window paces. In several recent examples of such design, the window spaces are fitted with double sashes, the upper halves of which are glazed with ribbed glass. In such a building the interior surfaces naturally are smoothly plastered and the floors of cement, so that lightness and cleanness are scarcely to be avoided in them. The double sashes serve the double purpose of preventing the distribution of dust and smoke, and of economizing the heating in winter.

A NOTABLE SUCCESS IN THE DESIGN AND ARRANGEMENT OF A FORGE SHOP.
One of the best in America. Plain (but not ugly), and excellently lighted. Note the interior view of the same shop on page 672. Deering Works, International Harvester Co., Chicago.

It would doubtless be difficult to point out an employer in the United States so foolish as to work his men in an unwarmed shop in winter. The disadvantage of cold and stiff fingers in turning out rapid and accurate work is too well understood now. Not every superintendent or foreman knows, however, that pure, fresh air is just as necessary as warmth. Many of the newer shops make provision for this; but in most of the older ones the only ventilation to be had is by way of the windows. Judiciously used, window ventilation does very well. Unfortunately, like many another simple and near at hand means, this is not thought of except during hot weather or in shops where noxious gases fill the air. The ventilation should go on at all times—at night when the shop is deserted as well as when filled with workers. As it is, even when sufficient ventilation is allowed during the day, the first thing the watchman does at night is to close securely every window, shutting in all the dust-laden and very likely devitalized air for use next day, often malodorous with the fumes and gases incident to the manufacturing process carried on. It would seem that the least that can reasonably be done, at times when windows may not be left open, is to arrange some means for introducing fresh air through simple ventilators placed in the windows, which will deflect the air coming in at the windward side of the building so as to avoid drafts upon those in the room. A small motor fan often helps to make such a method quite effective. Inattention to this matter usually brings its own immediate punishment in the reduced activity of the workers and their consequently diminished output. The injury to the health of the workers is often serious; and many a case of tuberculosis is directly traceable to an unventilated or improperly ventilated work room.

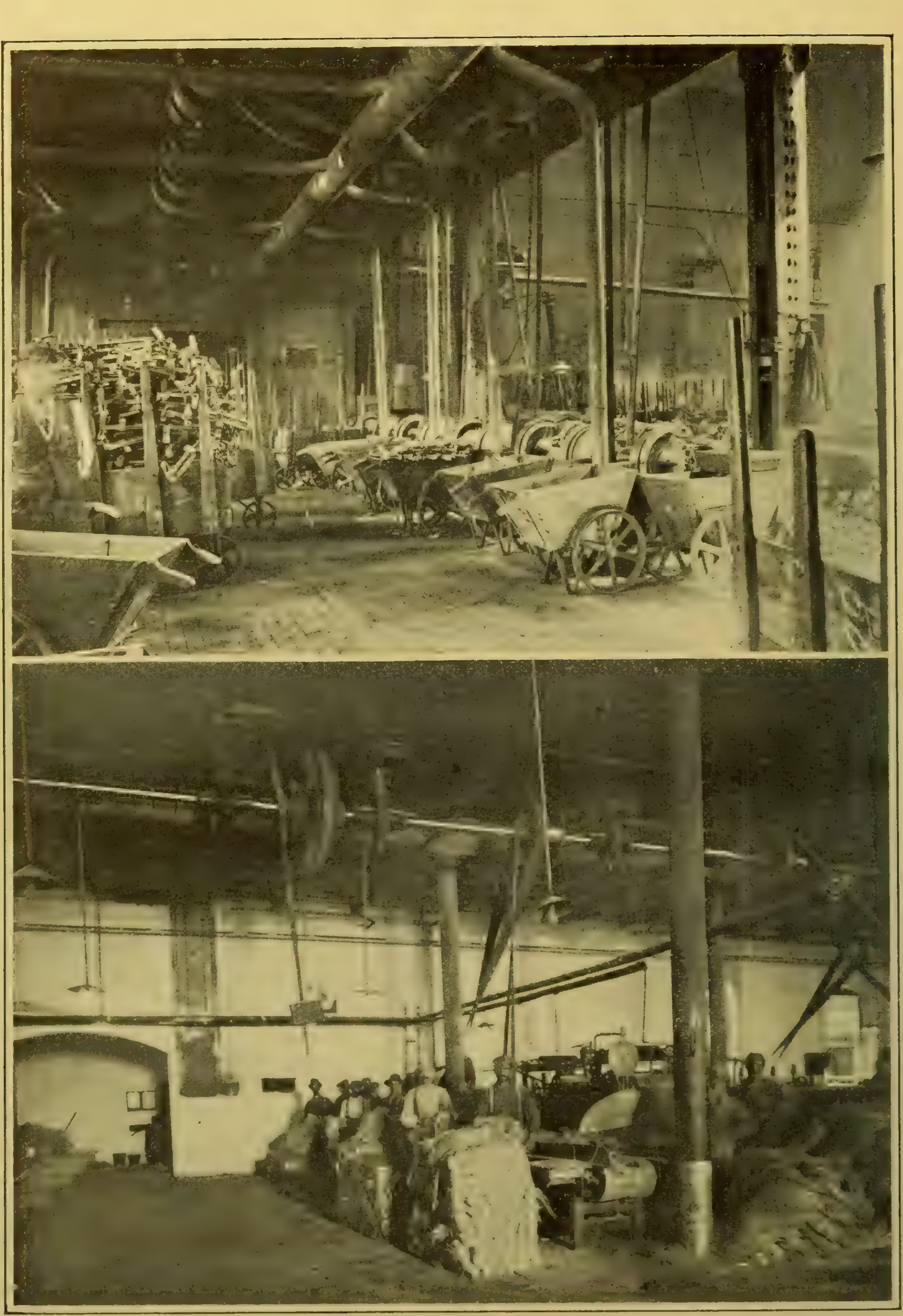


THE INTERIOR OF A THOROUGHLY APPOINTED FORGE SHOP.
Good light, thorough ventilation, cement floor; hoods over the heating furnaces are properly proportioned, and connected with exhaust pipes large enough to carry away all fume and smoke. Deering Works, International Harvester Co., Chicago.



EXCELLENT RESULTS SECURED IN SHOP CONSTRUCTION.

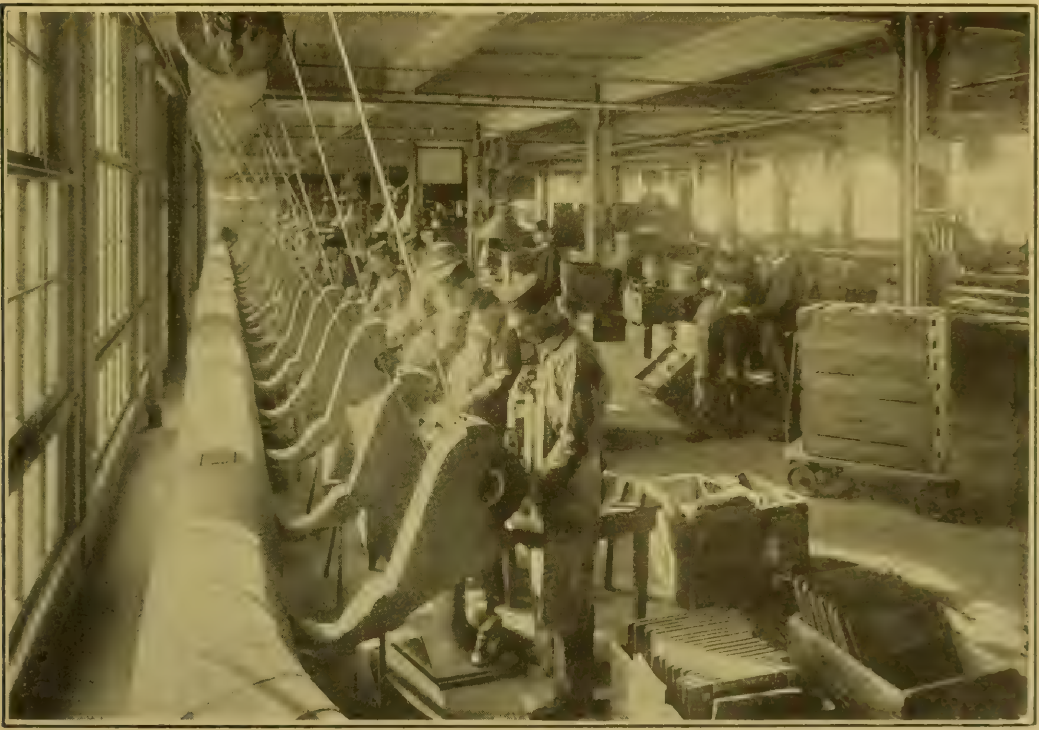
In the upper picture is shown a room which would otherwise be poorly lighted, but which is made bright and clean by light-painted walls and ceiling. It is a finishing shop of the N. O. Nelson Mfg. Co., Leclair, Ill. The lower one exhibits a strictly modern style of shop construction—steel and cement throughout, nearly all wall space devoted to windows, and these filled with ribbed glass. Satisfactory heating and ventilation. Jones & Lamson Machine Co., Springfield, Vt.



RIGHT AND WRONG IN THE MATTER OF SPECIAL VENTILATING DEVICES.

In the department illustrated in the lower view, operatives are at work opening bales of dusty fibre in a room with absolutely no provision for removing dust other than by opening the windows. The upper picture—taken in the same works—shows provisions for dust removal which are all that can be desired. The semi-hooded grinders connect with exhausts which draw away practically all the dust.

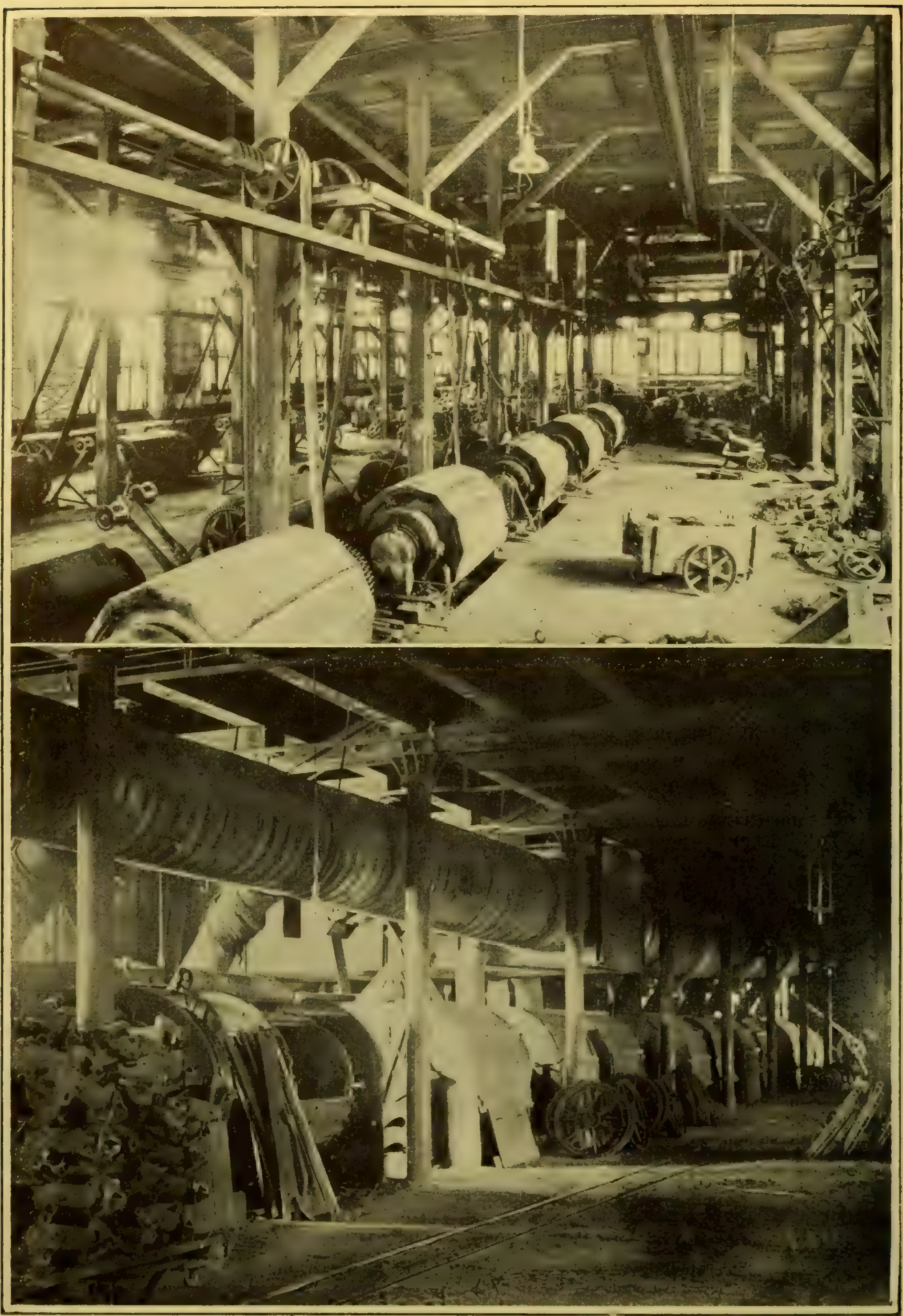
For the proper ventilation of shops wherein the atmosphere is quickly contaminated with gases or dust, windows are obviously inadequate. In such cases it is usually necessary to install a system of pipes and forced drafts. Nor is it enough to install it. Unless properly designed, such a system may actually be worse than useless. Consider what would happen in, say, a school building, were the air supplied for ventilating and warming the rooms that which was exhausted from those same rooms, over and over again. And yet there are a good many so-called heating and ventilating systems installed in factories which do just this.



A THOROUGHLY EQUIPPED AND SAFELY PROTECTED GRINDING ROOM.
Hoods for each wheel, with down-draft exhaust, remove all dust and particles.

In some States there are statutory provisions forbidding the contamination of the air in work rooms by dust from grinders, and possibly also in some instances by other common methods. The former great percentage of tuberculosis among men working as grinders has been much reduced since the practice of placing hoods connected with exhaust systems over dry-grinding wheels has become common.

But there are many other sources of dust than this. The worst conditions probably are to be found in some "milling rooms" attached to foundries. Ordinarily a large part of the dust formed in the "mill" escapes into the room. No system of ventilation, even were any such installed in a mill room thus equippped, could keep the air free of



ADEQUATE AND INADEQUATE DUST-REMOVING APPLIANCES IN FOUNDRY MILLING ROOMS.

The lower view shows the equipment in one of the largest American foundries. The tumbling barrels are of old type, allowing much dust to escape. Wooden enclosures with canvas flaps exhausting into the pipe above are installed, but so much dust escapes that the air of the room is thick by day and the dust on the floor lies deep by night. In the upper view (taken in the new Deering foundry) the rattlers are provided with positive down draft, the dust being carried into a duct underneath. There is almost no dust escaping into the room.

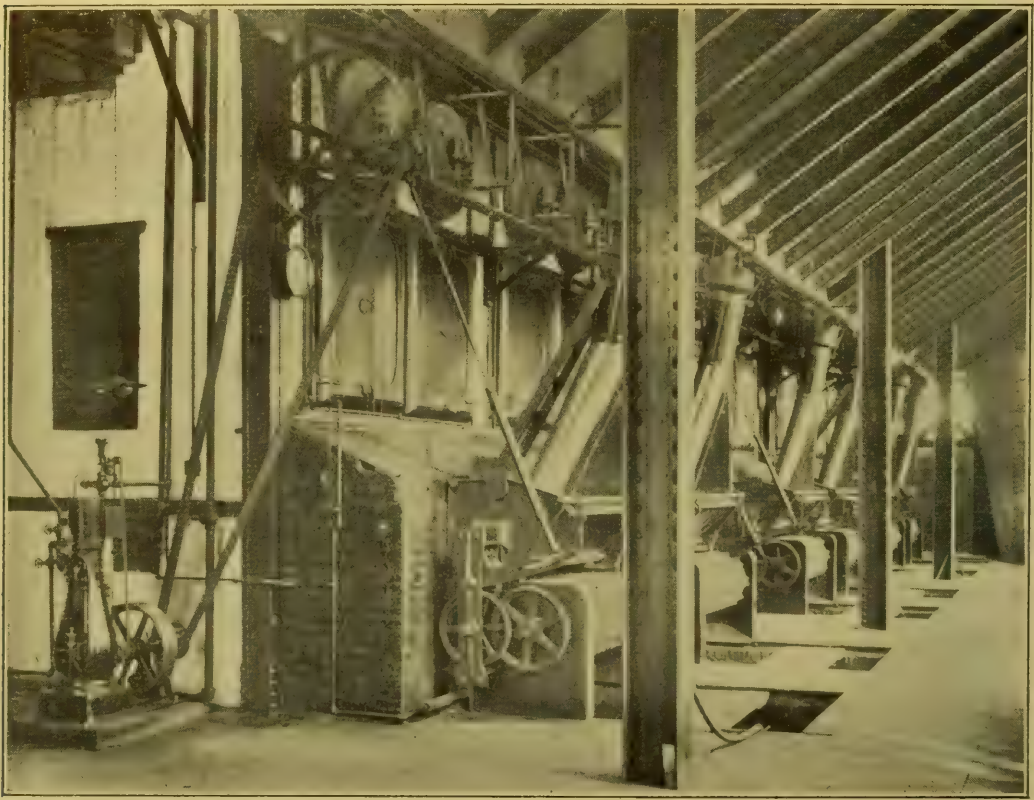
dust. The modern "mill" or "rattler" is designed with dust-proof casing, and proper down-draft exhausts connecting with the interior through a hollow-bearing shaft or similar device. There is no reason why the old-style "rattlers" could not be made dust-proof by an outer casing, properly connected with an exhaust; and indeed this is done in a few cases that I know of—but they are very few, indeed.

It is perhaps unnecessary to mention other operations which defile the air of the work room. But it is worth while to point out that wherever any such operation is carried on it is highly important to make provision for carrying off the dust or other recrement.

From a sanitary point of view it is important to keep work rooms clean. Considerations of economy also point the same moral. Janitor service of course entails expense, but slovenly workmen entail a greater loss; and slovenly workmen and workmanship are legitimately begotten of slovenly surroundings. If a shop is allowed to be dirty and cluttered up with waste materials, or even with good material in disorder, its character is impressed with absolute certainty on its occupants. There is doubtless much truth in the phrase that a shop is known by the workmen employed in it; but it is at least equally true that a workman is known by the kind of shop he works in. If he finds slip-shod management, which certainly is the case if disorder and filth prevail, nothing could be more natural than that he should come to regard such conditions as good enough and quite fulfilling the requirements.

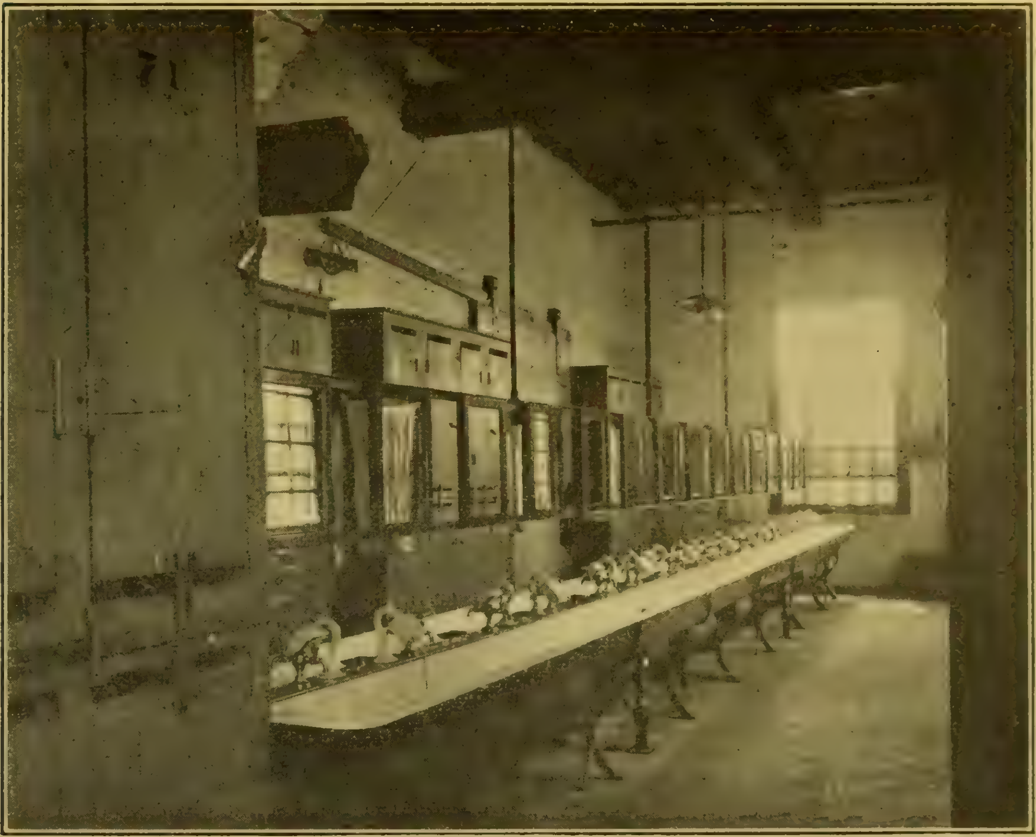
Keeping a shop clean is not so difficult a matter as might be supposed. In old buildings, put up with reference to little more than service as shelter for certain machinery, sanitation and cleanliness were well-nigh out of the question. Loosely laid floors raining dust and refuse upon the workmen in the rooms below, and rough walls and ceilings collecting masses of dust later to be jarred loose and to fill the air of the work rooms, are practically a thing of the past. Nowadays shops are constructed with reference to convenient and quick production, and therefore the cement floor and smooth wall and ceiling are much in favor. But even wooden floors can be laid close enough, and now are usually so laid, to prevent dust and waste from sifting through to the discomfort of those below. Under such conditions it is a matter of small expense to keep a shop reasonably neat and clean. Orderly arrangement of materials and proper care of their machines by the workmen, frequent sweeping, and occasional coatings of white paint or whitewash, are a combination that makes an astonishing difference in the spirit of a shop.

Manifestly there is a difference in shops, the difficulty of keeping one presentable depending very much upon the nature of the work carried on in it. Engine rooms have long been proverbial for their cleanliness and tidiness, frequently putting to shame the average housekeeper's kitchen. The modern boiler room, equipped with automatic stokers and coal shoots, is susceptible of equal neatness of appearance. One would not expect an ordinary shop always to be looking spick and span. Nevertheless there are places where just such shops are kept constantly in just this condition. Even a foundry and a rolling mill, of all places presumed to be necessarily about the dirtiest, have been known to present a satisfactorily neat appearance.



TYPE OF MODERN BOILER ROOM, WITH OVERHEAD COAL BINS AND AUTOMATIC STOKERS.
It can be kept as clean as most offices, and sometimes with less labor. Green Engineering Co., Chicago.

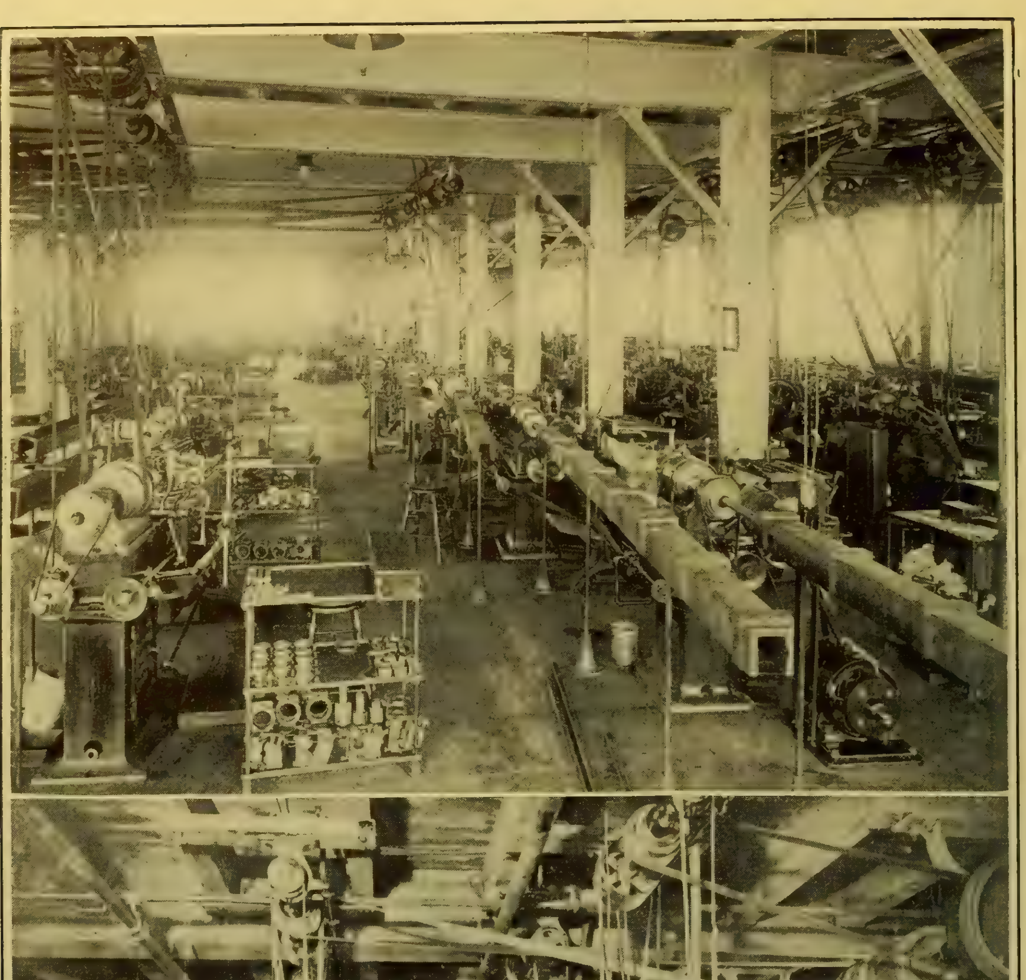
Next to cleanliness in the shop is cleanliness in the person of the work people in it. It is really inspiring to look into a work room filled with trim and tidy operatives. Such neatness and order is equally inspiring to the workers themselves. It is manifestly impossible, however, that such conditions should prevail in all workshops, under present manufacturing practice. Many occupations are in their nature unclean, and perhaps even filthy, so that personal cleanness could not be expected of the worker while at his task. But even in such extreme cases it is possible to provide facilities for cleaning up after the work is done. Time was when even a bucket and water for washing were considered, if thought of at all, as superfluities, possibly to be tolerated in a country shop, but quite out of place in a factory. It is, indeed, quite out of place in these days of improved sanitary appliances; but unfortunately the devices which should supersede the bucket are lamentably inadequate, or more frequently quite wanting.



AN IMPERFECT APPROACH TO EFFECTIVE LAVATORY ARRANGEMENTS.

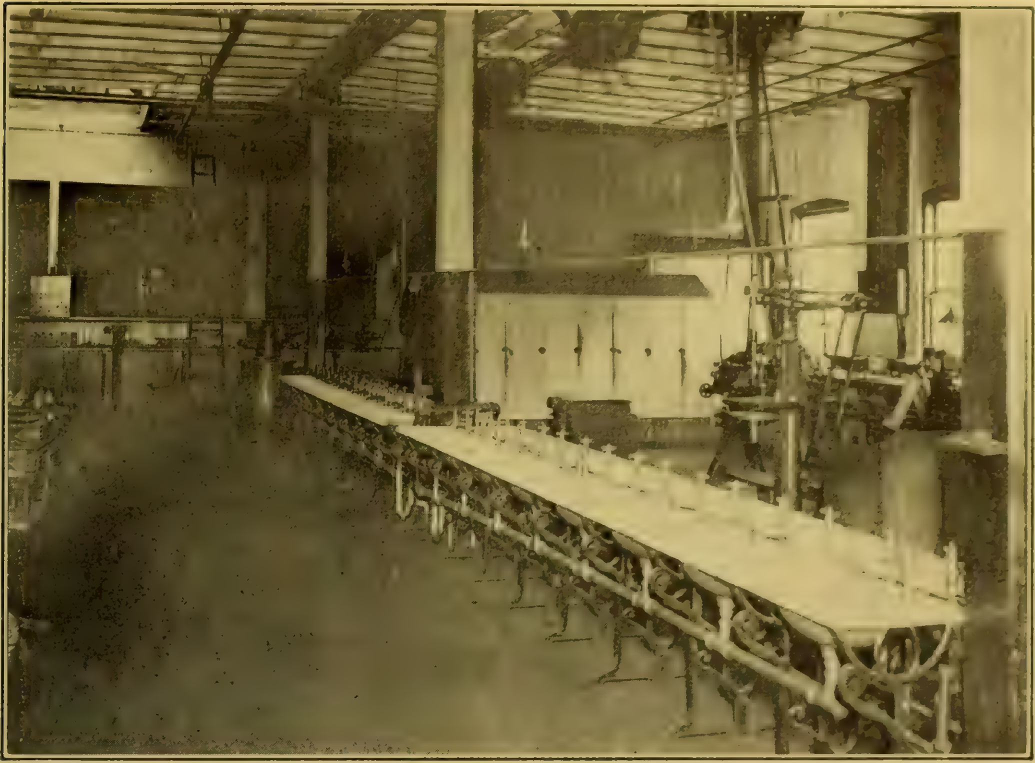
Workmen take unkindly to the single long trough, on account of its promiscuous democracy; moreover, it could hardly be called sanitary. To supply cold water, only, is further inadequate to the requirements of a workshop wash-room.

It is doubtless true that work people in general, such as are to be found in the factories at any rate, laçk somewhat in the finer sensibilities; the great majority of them nevertheless are decent and self-respecting men and women, with a distinct preference for personal cleanliness and a desire to make a decent appearance. If they are seen on the streets reeking with the odors and the filth of the shop, it is not ordinarily from choice, but necessity—from lack of opportunity to clean themselves up after a day's work. The embarrassment arising from this necessity is often painful. When it is possible for her to do so, the girl in the mill or dusty shop appears on the street look-



A CONTRAST IN INTERNAL ORDER AND SHOP CLEANLINESS.

The upper view, of an automatic screw-machine room which fairly shines with cleanliness, is taken in the works of the Jones & Lamson Machine Co. The lower is best judged by contrast with what it might be. The expense of providing proper pans for the machines, and thus saving the workman from the necessity of wading through slop and steel turnings to reach his job, would be but slight. The moral effect would be great.

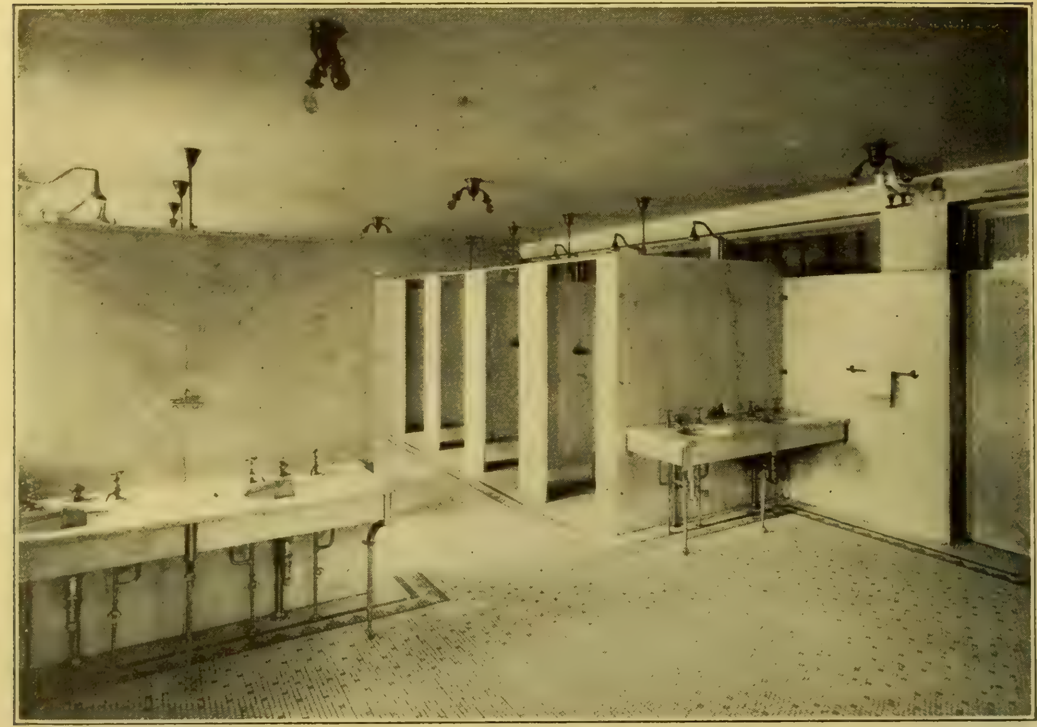


A LAVATORY INSTALLED IN A MACHINE SHOP.

Individual bowls provided with hot and cold water; the men furnish their own soap and towels. Not a man in the shop goes home unwashed. Metal Pattern Shop, McCormick Works, International Harvester Co., Chicago.

ing as tidy as her sister of the department store or office who prides herself on being a lady. The difference, obtrusively apparent, in the appearance of the employees of two shops, the one offering opportunity for washing and a change of clothing, and the other without such conveniences, is surprising; and it is entirely independent of the personality of the work people except in so far as that personality is influenced by the natural drift of the superior men and women toward the shop offering the better conditions.

The new idea is that every shop should have within easy reach a satisfactory lavatory equipment and lockers connected with a changing room. The old way of hanging the street clothing against the grimy shop walls to catch the floating dust, and leaving the shop clothing (if any change was made at all) on the floor where it was stripped off at night until it should be required again next morning, is in accord with the old way of inviting workmen to wash up from a dirty and unsanitary bucket filled with cold water. There are, however, so-called lavatories that are little better than the odorous bucket, and lockers that are little improvement over the former peg on the wall. Some employers have expressed surprise that their workmen

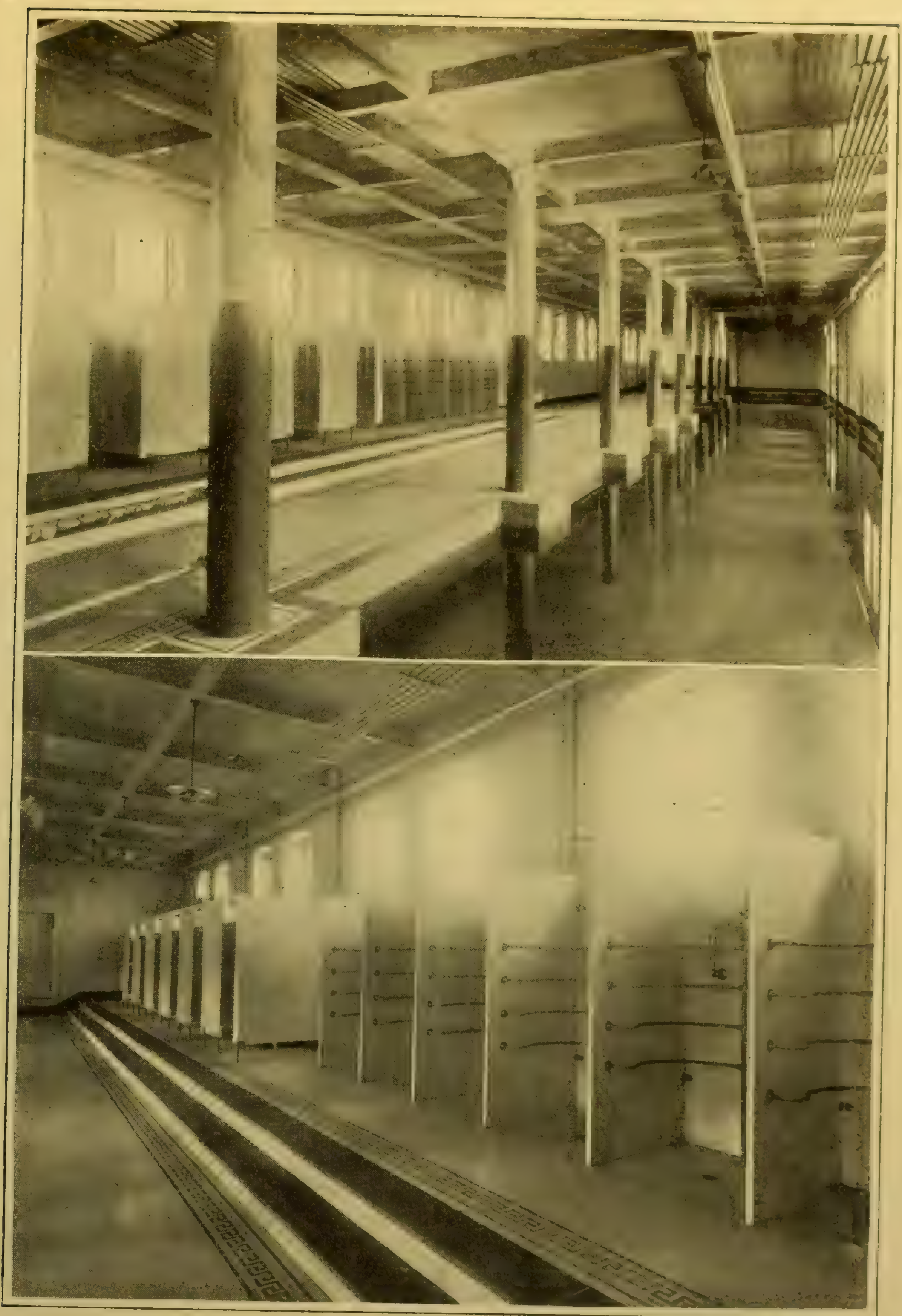


AN ELABORATE LAVATORY AND BATH FOR WOMEN EMPLOYEES.

Factory of the National Food Co., Niagara Falls, N. Y. They say it is "worth while."

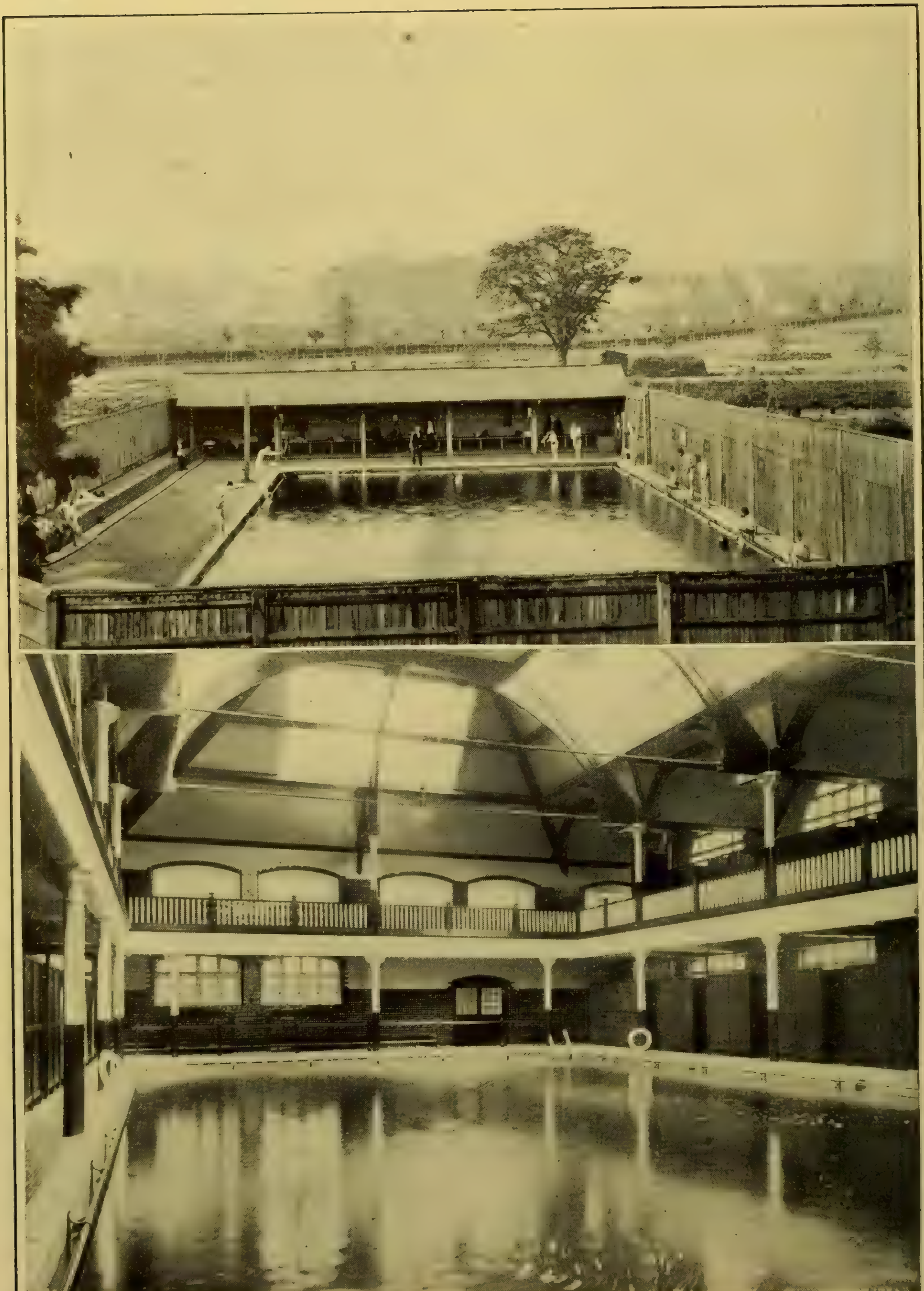
did not make use of such facilities after they had been supplied. The reason is in such cases usually not far to seek.

The usual method in the past, when anything was done at all, was generally to put up a long trough, supplied with cold water. This, and nothing more in the way of lavatories. Anybody who has ever tried to wash off shop dirt and grease with cold water, even when well soaped, will see at once why a workman will prefer to go dirty until he reaches home and hot water, soap, and towel. Furthermore, the long trough, even if hot water be supplied, is unsanitary; and its promiscuous democracy is rather more than is to be expected, even of democratic workingmen. The surprising thing is not that such facilities are so little used, but that they are used at all. Very likely there are shops whose working force would need educating up to the use of anything of the kind, no matter how convenient or agreeable; but in the average shop a proper equipment never yet has gone to waste for lack of use. It is perhaps too much to expect, or even to hope, that people of the type usually found nowadays in those shops whose work, from its nature and the pay it commands, falls into the hands of the most ignorant and incapable, should at once change the habits acquired during a lifetime spent in working surroundings discouraging all efforts at cleanliness, and probably decency also. Even so, the em-



A REALIZATION OF THE IDEAL IN BATHING FACILITIES FOR THE SHOP.

In the upper view, is shown the means adopted to make the necessary water-storage for power purposes serve as a swimming basin. The lower picture is of shower, needle, and tub baths. Both are at the works of the Weston Electrical Instrument Co. It must be borne in mind that "the highest possible efficiency" was everywhere the controling idea in the construction of this plant.



BATHS IN THE BOURNEVILLE ESTABLISHMENT, ENGLAND.

The upper picture illustrates an open-air swimming pool, of very simple design, for the male employees, the lower one shows the girls' bath, with swimming pool and dressing rooms.

ployer is not thereby excused from doing his duty by offering the facilities that help so largely to the creation of a healthy self respect.

A foundry manager argued not long since that if he provided his men with the conveniences I proposed (the toilet-room provided for them was the out-of-doors and a scantling supported by two stakes set into the ground) and they actually came to make use of them, they would become too "high-toned" to work in his shop, and he would be obliged to pay higher wages or to be taking on new men all the time. Undoubtedly the "tone" of the workmen would be raised. And as for the rest, experience does not show that there is difficulty in keeping men in shops, of whatsoever sort, where the "square deal" obtains, at the prevailing wage rate.

The lavatory, to be satisfactory, should have a sufficient number of separate bowls, no matter how simple; hot and cold water; an arrangement for supplying soap; and some sort of towel service. The bowls may be only ordinary basins so arranged that their contents may be tipped into a drain trough below. The modern enameled-ware stationary bowl is of course preferable; but the first described can be very cheaply installed, which may be a consideration. The hot and cold water are not necessarily drawn from supply pipes, though that is much the better way. A steam pipe for heating a sufficient supply at the proper time will do, if the better plan be not feasible for the time being. As to soap and towel service, the workmen are usually willing to supply themselves. The superiority of a regular service and the small expense involved suggests the advantage of its being undertaken by the management.

For some classes of shops—those in which the operations are in their nature dusty, or for any reason occasion a great deal of perspiration—wash bowls do not sufficiently meet the situation. In such cases the whole body becomes more or less filthy, and needs a bath. The shower bath fully satisfies the need under such circumstances. These can be simple or elaborate, the same as all other sanitary equipment. In a few establishments the bath and lavatory appliances are not surpassed in elegance by those of the best hotels. For foundry or coal-mine operatives such equipment is manifestly out of place—too fine to be used; and the simplest styles, if properly installed, are not only good enough, but the only ones that would be much used. The essential requirements are reasonable privacy, plenty of water of suitable temperature, soap, and towels. Such are now to be found in many up-to-date foundries and similar shops.

The idea of cleanliness is in some instances still further developed by some employers. Under any but exceptional circumstances the working clothes inevitably get soiled, and not infrequently very dirty. A clean shop implies cleanly clothed work people. In an increasing number of factories, therefore, the laundry is an essential part of the equipment. In some cases the work garments are laundered for the employees, usually free of charge. In others the management supplies, at a stated charge or free, as the case may be, outer garments for use in the shops and keeps them properly laundered without expense to the employees. In some establishments, as for instance factories producing food stuffs, where scrupulous cleanliness is essential, such a course is almost necessary. In paint mills and similar factories it is very desirable as a measure of protection to the health of the operatives. In every factory there would be a gain were cleanliness and neatness thus encouraged.

A substitute for the factory laundry, satisfactory as far as it goes, is that adopted in one large plant, and doubtless in use in others; namely, that of allowing some laundry to send its representative through the work rooms at stated times to collect garments for laundering from those work people wishing to take advantage of the service and willing to pay the cost. Since the laundry privilege was

STEAM LAUNDRY FOR TREATING EMPLOYEES' SHOP CLOTHING, FREE OF CHARGE.
In some of the departments a daily change is provided. Factory of the Sherwin-Williams Co., Cleveland, Ohio.

AN EXAMPLE OF A MODEL MACHINE-SHOP LAUNDRY.
Situated on a top floor, well lighted and ventilated, and equipped with modern labor-saving appliances. Uniforms are issued to certain classes of employees; laundering is free of charge. National Cash Register Co.

granted in this factory there has been a noticeable improvement in the appearance of the shop people. Furthermore, there is an increasing disposition to make use of the opportunity thus afforded. That is to say, the shop people are educating themselves in this particular respect, simply by the tolerance of the management, which is at no expense whatever.

Another expedient which serves a useful purpose is that employed at a few mines. In the "changing house," (Cleveland-Cliffs Iron Co., Ishpeming, Mich.) there are, besides the wash basins, shower baths, and lockers, racks supplied with steam coils, whereon the perspiration-soaked working clothes may be spread and thoroughly dried before being worn again. The comfort, to say nothing of the advantage from a sanitary point of view, derived from this thoughtful arrangement scarcely needs to be pointed out.

Similar arrangement, sometimes in the form of lockers provided with steam coils, has been installed in certain department stores and factories to dry the outer garments of women employees obliged to expose themselves in rainy weather—an arrangement that saves many a cough and possible illness.

PRESENT CONDITIONS SOUTHERN ALASKAN MINING DEVELOPMENT.

By Wm. M. Brewer.

IN discussing this subject I propose to confine myself to that portion of Alaska which embraces the mainland along the coast line and adjacent islands, from the south end of Prince of Wales Island to Kodiak Island lying to the east of the Alaskan Peninsula. Within this area are located nearly all of the quartz or lode mines so far discovered in United States territory in the great North Land, but few placer diggings—in fact, none of the placer camps which are to-day receiving so much attention and yielding such phenomenal outputs of gold dust and nuggets.

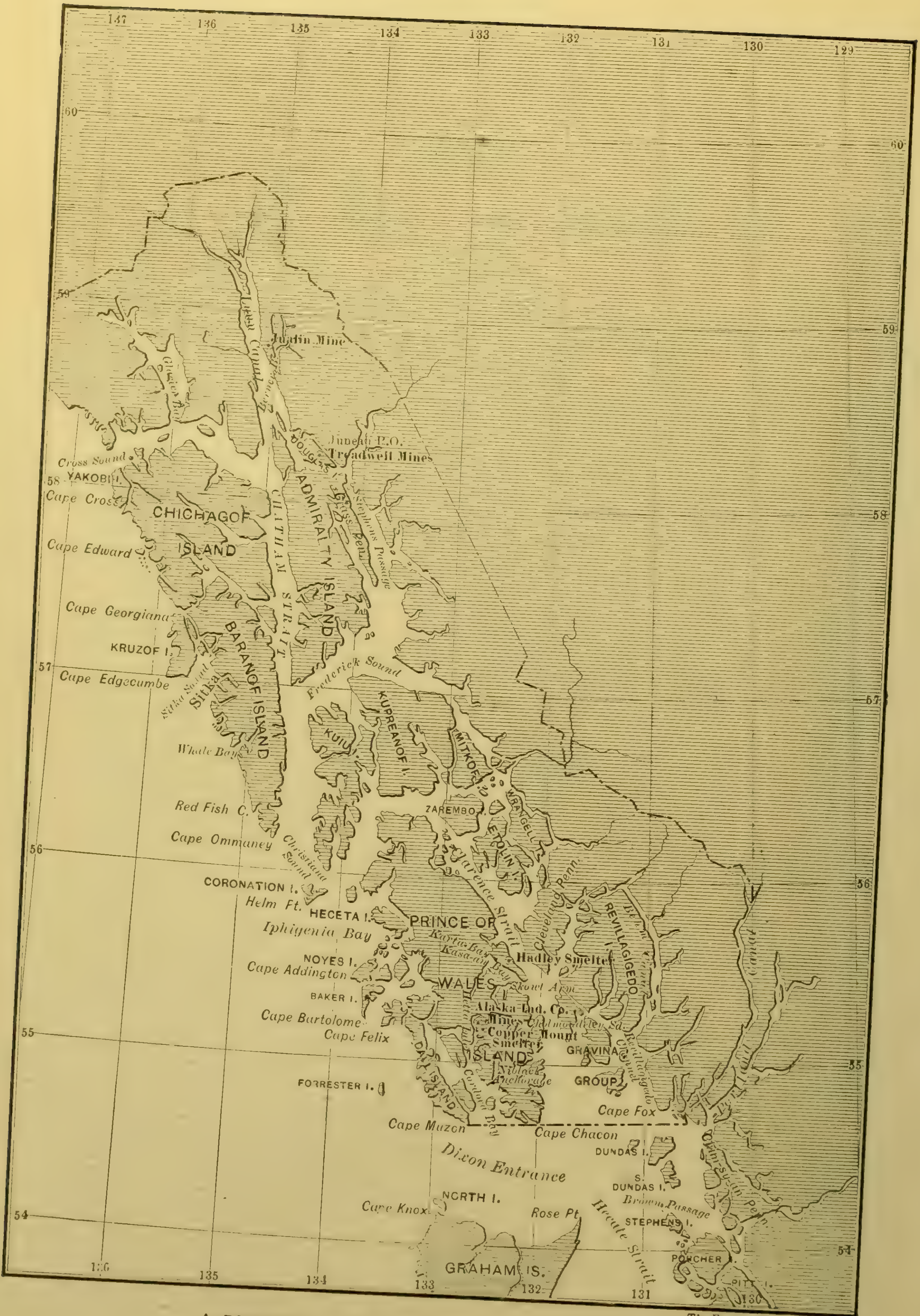
When it is considered that the length of this coast line, according to the route travelled by the steamers which make regular trips to those Alaskan ports to the westward from Sitka, is about 1,600 miles, via what is known as the inside channel, it can readily be understood why I confine myself within the boundaries given, and do not propose to attempt to discuss the development in the placer camps in the more northerly portion, which covers a far larger area.

Except the Juneau district, where placer mines were operated as early as 1884 (when gold-bearing gravel was discovered in Silver Bow Basin, and the famous Alaska Treadwell quartz mine was located) all the territory described in this article was practically *terra incognita* so far as concerns its mineral resources, until after the discovery of placer gold in the Canadian Yukon or Klondike proper, in 1896. One does not wonder at this, either, when he has sailed along the coast and observed the difficulties to be encountered by the explorer. Viewed from the deck of the vessel, the dense growth of underbrush, almost impenetrable forests, and precipitous mountain ranges, in many of which are glaciers covering enormous areas, apparently present obstacles which even the hardiest and most venturesome prospector would hesitate before attempting to overcome. However, of the many thousands who started to cross the passes and travel down the Yukon River to the Klondike, a few took up the task of prospecting along the coast line. They argued that other "Treadwells" might be found, and that reasoning was to a great extent responsible for the present condition of the development of lode mining on Prince of Wales Island, Prince William Sound, La Touche Island, Illiamna Bay, and near Sunrise City on Turnagain Arm, the head of Cook's Inlet. Of course by far the most extensive development has been carried on in the Juneau district, where the Treadwell group of mines alone have produced upwards of $21,000,000 in bullion since 1884, to say nothing of other mines in the same district; but in this article I propose to start my description of the districts at the southern boundary of Alaska and take up each camp from that point of geographical order, from south to northwest rather than according to its importance or age.

Prince of Wales Island.—Previous to 1898 but little prospecting had been done on this island, and that had been confined to the western side, chiefly in the vicinity of Hetta Inlet. Since then, and especially since 1900, the island has been quite extensively explored, until today there are mining camps located every few miles along the eastern coast line in addition to those on Hetta Inlet on the west side.

There are two smelting plants, one owned by the Brown Alaska Co., with a capacity to treat about 400 tons of copper ore per day, situated on the east side of the island at Hadley, on the north side of the Kasaan Peninsula; the other owned by the Alaska Copper Co., with a capacity of about 200 tons of copper ore per day, situated at Copper Mount on Hetta Inlet. The first-mentioned of these was erected to treat the ore from the "Mamie" mine, situated near the top of the mountain on Kasaan Peninsula about 1½ miles from the smelter, and the last-mentioned to treat the ore from the group of copper properties situated on a high mountain in the immediate vicinity of the smelter, which were the first discoveries of copper-ore deposits on the island. During the past year more serious attempts at systematic development have been made on this island than during all the previous years since the first discoveries of ore bodies.

The geology of Prince of Wales Island can hardly be worked out in detail for years to come, notwithstanding the good work that is being done annually by members of the United States Geological Survey. The surface is covered with so much moss, underbrush, and fallen timber that the natural exposures of the rock formations, except where mountain streams have cut their channels, are very few and far between and usually near the summits; to climb these without the aid of beaten trails is really a formidable undertaking, and means that the explorer must pack on his back his blankets and supplies, and travel very slowly.



A PORTION OF THE SOUTHERN ALASKAN COAST.
From the chart of the Coast and Geodetic Survey.

Hetta Inlet is a long arm of the sea which penetrates into the Island a distance of about thirty miles. About five miles above the properties of the Alaska Copper Co. is situated Jumbo Basin, only a comparatively short distance from the southeasterly shore of the inlet. In this basin are located a portion of the properties owned by the Alaska Industrial Co., on which a considerable quantity of development work has been done during the past five years. At the present time tramways are being constructed to convey the ore from these properties to the shore.

There are besides the properties referred to quite a large number of prospects in the mountains in the vicinity of this inlet, on which assessment work has been done; one of the most promising is a claim located in January last by H. C. Corbin on which he discovered an ore body of considerable extent, as has been demonstrated by actual work. The distance from this ore body to a deep-water wharf is less than half a mile. The location of this mineral claim is nearly midway along the coast line between Copper Mount and the landing for Jumbo Basin.

The general character of ore is chalcopyrite, except on the Alaska Copper Company's property where quite a considerable tonnage of copper-carbonate ore occurs at an altitude of about 4,500 feet above sea level. The altitude of the other occurrences is much lower than this, and there is no oxidized zone; in fact, so far as I have observed, there is no well defined zone of oxidation on Prince of Wales Island except the occurrence referred to on Copper Mountain.

From the head of Hetta Inlet across the island to the head of Cholmondeley Sound on the east side is a distance of only about 4 miles over a very low divide, the summit of which does not exceed 250 feet. This is the route generally travelled from the west side to the east, and as there are no other properties on the west side of the island that have been developed to any appreciable extent I will cross this portage in this description and take up those properties on the east side that have been opened up there.

From Cholmondeley Sound one sails into Clarence Strait, a wide sheet of water which separates Prince of Wales Island from Annette and Graviana Islands. A few miles southwesterly from the entrance to Cholmondeley Sound down Clarence Strait is situated Niblack Anchorage, where are located some extensive bodies of chalcopyrite ore occurring in a greenstone country rock. One of these is being operated by the Niblack Copper Co., which last winter built wharf, bunkers, and tramways from the mine shaft situated only a few hundred feet from deep water. This company has since shipped about

10,000 tons of ore to the smelter at Tacoma in the State of Washington.

Leaving Niblack Anchorage and travelling a few miles up the coast one reaches Dolomi mining camp, where operations have been carried on for the past five years on some comparatively narrow veins of gold-bearing quartz, partially free-milling. Some of this quartz carries phenomenal values, the gold contents reaching as high as 18 ounces to the ton. These samples were from the Valparaiso mine, which is the most extensively developed in the camp. On another property in this camp a small stamp mill was erected some time ago and operated until recently. It is however more economical and also more profitable to ship this character of ore to a smelter than to treat it by amalgamation, unless very good concentration is effected.

After leaving Dolomi one has to travel along the east coast of Prince of Wales Island about twenty miles, or to Skowl Arm, a beautiful bay affording excellent anchorage, to reach the next mineral property where any extensive operations have been carried on. There the Omar Mining Co. is developing and operating the Khayyam group of mineral claims located in the mountains about four miles from the shore. This company has constructed wharf, bunkers, a gravity tramway to the foot of the mountain a distance of nearly three miles, and an aerial tramway up the mountain to the mine 4,600 feet away, and is shipping ore to the Smelter of the Tyee Copper Co. at Ladysmith, Vancouver Island, British Columbia, for treatment. The ore body on this property differs in many respects from any of those already referred to. In character the ore is a pyrrhotite closely associated with iron pyrites and chalcopyrite. Cross cutting and drifting have demonstrated that near the surface the ore body possesses very considerable extent, and if this extent remains constant as greater depth is attained the tonnage from this property will be immense.

The next mineral-bearing zone is found on Kasaan Peninsula and in the mountains at the head of Kasaan Bay and Karta Bay, which is to all intents and purposes a portion of Kasaan Bay.

At Hollis mining camp at the head of Kasaan Bay there occur several veins of gold-bearing quartz very similar in character to those referred to in the Dolomi Camp, while at the head of Karta Bay the ore bodies are chalcopyrite, in a magnetite gangue in some instances and closely associated with pyrrhotite in other cases.

In the Hollis Camp the ore so far found has been treated by amalgamation in small stamp mills, but in the camp at the head of Karta

CAPE ST. ELIAS, ALASKAN COAST.

Bay the ore mined has necessarily been shipped to smelters, and during the latter portion of the present year one property, known as the Rush and Brown, has been operated under lease by the Alaska Copper Co., and another known as the Newell and Metzdorf is being operated under option by the Britannia Smelting Co., owners of the Crofton smelter on the east coast of Vancouver Island.

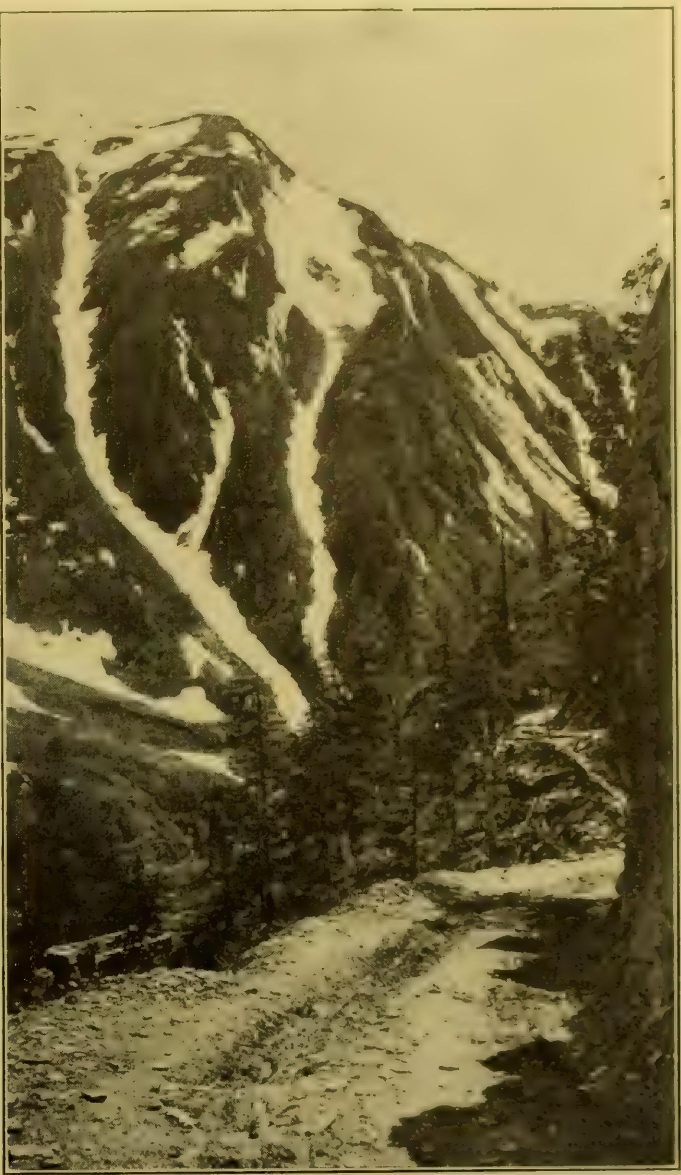
On Kasaan Peninsula proper the chief development work done up to the present time has been confined to the Mamie, owned by the Brown Alaska Co., the Stevenstown, owned by Sam Silverman and Associates, the Mt. Andrew, under option to the Britannia Smelting Co., and the White Eagle, owned by Sam Silverman and Associates. All of these properties are located at and near the summit of the mountain which really forms the Peninsula. The ore bodies are more or less extensive deposits of magnetite, carrying variable values in copper contained in chalcopyrite disseminated through the magnetite in particles of variable size. The general character of the country rock is a greenstone, much of it resembling a diabase or diorite, and occurring as enormous intrusive masses and dykes which have metamorphosed the limestone with which it contacts altering it to crystalline. Some of the ore bodies occur as contact deposits between the limestone and greenstone, while others occur as lenses in the greenstone. Both the Mamie and Stevenstown have been developed during the past year into shipping mines, the ore being transported by tramway to the Brown Alaska Company's Smelter at Hadley situated on the northerly side of the Peninsula.

In addition to the foregoing developments there have been operations carried on during the past year on the east side of Prince of Wales Island in quarrying marble for building and decorative purposes.

Capital was brought into the Kasaan camp in larger amounts and at an earlier date than into most of those on Prince of Wales Island. This has resulted in the building of the smelter at Hadley on the northerly side of the peninsula, as well as in the extensive development which has been carried on at the Mamie, Stevenstown, Mt. Andrews, White Eagle, and other mineral claims. From the two first mentioned during the past year about 25,000 tons of ore have been mined and delivered at the smelter.

The operations of the smelters on Prince of Wales Island will be watched with a good deal of interest, for the reason that all the fuel will have to be freighted either from Puget Sound or Vancouver Island, which means in either case an ocean haulage of about 600 miles in the direction that has always commanded high freight rates. Fuel from Vancouver Island will be subject to a duty, but its superiority in quality over Washington fuel is so generally recognised that it is almost certain the smelting companies will find it more profitable to use that fuel and pay the duty than to attempt to use Puget Sound coke or coal. Up to the present writing, active operations can hardly be said to have commenced at either of the smelting plants on Prince of Wales Island, but the managements of both are concluding arrangements to blow in for a steady run at once.

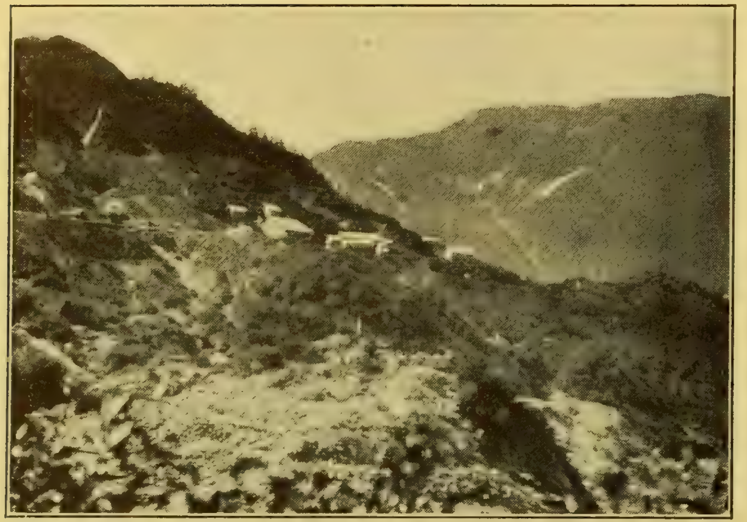
Revillagigedo and Graviana Islands.—On the islands lying between Prince of Wales and the mainland but comparatively few discoveries of ore bodies have been made, although, with the exception of Annette Island which is considered an Indian Reservation and on which no prospecting by white men is allowed, considerable prospecting has been done on Revillagigedo, Graviana, and Grindell Islands. On Revillagigedo, quartz veins carrying gold values partially free-milling were discovered some years back, and on the Sea Level group of claims a stamp mill was erected in 1901 and operated for about a year. This is at present idle, owing to some legal questions regarding ownership. On Graviana Island gold-bearing quartz occurs in a talcose-schist country rock which carries sufficient values to warrant mining and milling operations. Some specimens of this ore are of exceptionally high grade and show particles of free gold as large as grains of coffee, and when sorted with reasonable care the ore carries about $30.00 to the ton.



IN SILVER BOW CAÑON.

The prevailing country rock on both of these islands is schist, much of it being garnetiferous and talcoid in character. Sufficient exploration has not been done to determine the full extent of this belt of schist, either as to its width or length, but it is interesting to note that country rock of similar character is found at other points along the coast towards the north-west, notably in the vicinity of Wrangell, and also in the Juneau District, but no discoveries of ore bodies of importance have been reported either on islands, or on the mainland between Prince of Wales and Snettisham Bay which may be considered the south-easterly boundary of the Juneau District.

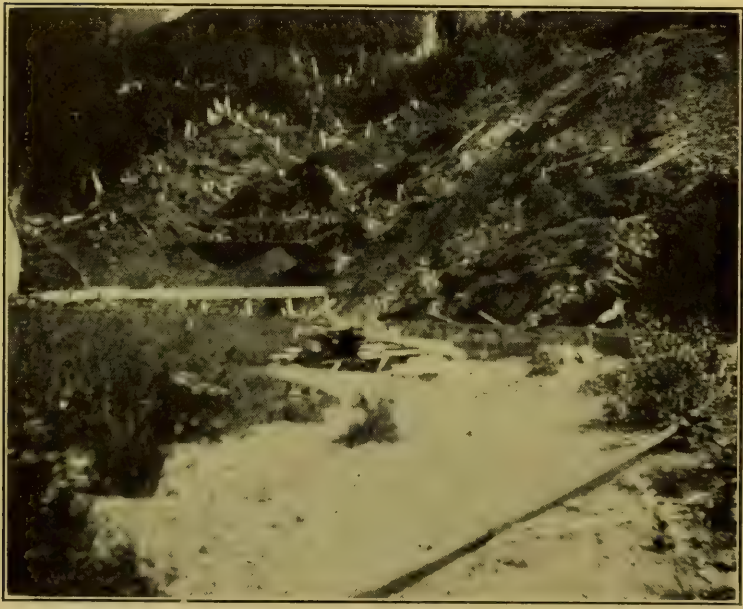
Juneau District.—Berner's Bay, a harbor on the East side of Lynn Canal, may be considered the north-westerly boundary. The greatest activity at the present time in this district is seen in Douglas Island, where are situated the Alaska-Treadwell, Alaska-Mexican, and Ready Bullion mines; in the Silver Bow Basin, back of the town of Juneau



ALASKA-JUNEAU MINE, SILVER BOW BASIN.

on the mainland, where are located the Ebner, Alaska-Juneau, and Perseverance quartz mines, as well as some hydraulic diggings in the basin proper; on Silver Bow Creek; on Eagle River, and in Berner's Bay, on the Jualin mine. The Treadwell group of mines are to the Juneau district what the Homestake group are to the Black Hills. In the latter, there are in addition the Golden Reward group and a few other producing mines, so in the former we find the Jualin, the Eagle River, and the Ebner mines today producing practically all the bullion outside of that produced by the Treadwell group. In the near future the Alaska-Perseverance mine situated at the head of Silver Bow Basin, and the Greek Boy on Berner's Bay, will be added to the present producers.

One of the most interesting features connected with the Juneau mining district is the method of mining employed underground in the Treadwell group, where no attempt at timbering in the stopes is made, notwithstanding the fact that these are upwards of 200 feet wide and 1,000 feet long.



MILL SITE, ALASKA PERSEVERANCE MINE, SILVER BOW BASIN.

In opening a new level a drift is driven along the strike of the ore body, and every 60 feet along this drift an upraise is made 20 feet in height, which is timbered and later serves for a chute to discharge ore from the stopes above into the cars. From the top of these upraises stoping is started and extended in every direction except downwards; the machine drills are set on the broken ore, of which fully two-thirds is always kept in the stopes, until the entire body of ore between two levels, except the 20 feet left above the drifts, is stoped out. In addition to leaving this horizontal body of ore there are several vertical pillars left in the stopes, through which at regular intervals are driven man holes, by which method miners can obtain ingress and egress between the various chambers in the stopes. By working in this way the cost of timbering is eliminated, and by leaving two-thirds of the broken ore and the vertical pillars until the ore body is stoped out between the levels, a factor to insure safety from caving has been introduced.

EBNER MINE, SILVER BOW BASIN, JUNEAU DISTRICT.

Eventually it is proposed not only to stope out the vertical pillars, but also the 20 feet of ore left above the drifts. When this is done the entire workings will present the same appearance, only on a much more extensive scale, as the Glory Hole does at the present time. The dimensions of this are about 270 feet in depth, about 300 feet in width, and some 800 feet in length.

The high-grade ore mined in the Eagle River and the Jualin Mines last season has proved a strong incentive not only to prospectors, encouraging them to explore the country more thoroughly, but to the owners of partially developed prospects and idle mines, leading them to renewed efforts to persuade capitalists to invest. When such results accrue from systematic development as was the case in the Jualin

Mine on Berner's Bay—where late in the season the apex of a new ore body was exposed in a drift and proved to be 350 feet in length, the ore from it yielding in free gold on the plates and in the batteries $25.00 per ton, in addition to the values carried by the concentrates—owners of other properties in practically the same geological formation certainly have cause to feel that capital judiciously invested may result in placing mines idle today among the list of producers tomorrow.

As a matter of fact, in the case of the Jualin Mine, the owners, on the advice of the superintendent (Mr. W. W. Hoggatt) had arranged for the expenditure of capital in development during this season, but to their agreeable surprise the ore body they were seeking was exposed when the season was about half expired, and the ore proved to be of considerable higher values than the owners had anticipated.

THE TREADWELL MILL AND MINE.

Prince William Sound District.—To the north-westward from the Juneau district no metal mining is being done between Berner's Bay and Ellamar, in Prince William Sound. The earliest discoveries on Prince William Sound were the Gladhaugh mine at Ellamar and the property known as the Beatson mine on La Touche Island. Both of these properties have been shipping copper ore, much of it carrying in the neighborhood of 10 per cent copper per ton, for the past two years. The tonnage shipped by the Gladhaugh has been from stoping from the various levels to a depth of 500 feet, but the ore shipped from the Beatson mine has been principally the quantity removed in doing development work. This property is phenomenal in several respects. Exploitation through a cross-cut tunnel at a depth of some 200 feet below the apex of the outcrop has demonstrated that the ore body is about 200-feet wide, of which width some 35 feet carries exceptionally high-grade copper ore while the average of the balance of the ore body is about 5 per cent in copper.

IN THE PIT, TREADWELL GOLD MINES, ALASKA.

The outcroppings on this property are chiefly found in a bold bluff, almost immediately over the cross-cut tunnel, and the ore body has been traced along the surface for a considerable distance in both directions from this bluff. During the summer season a considerable tonnage of shipping ore is quarried from the face of the bluff, but no ore is stoped down from above the cross-cut tunnel in the underground workings. A second tunnel is being driven at a level about 100 feet below the one already referred to. When this tunnel intersects the ore body it will be made the main working tunnel, and all ore will be trammed through it to the bunkers on the wharf, about a quarter of a mile distant.

The visitor to the Beatson property on La Touche Island cannot help but be very favorably impressed not only with the property itself but also with the surroundings, for no expense has been spared to make all the buildings as substantial and as comfortable as are those in any of the older mining camps. Evidently the comfort of his workmen has been one of the main considerations taken into account by Mr. Beatson the manager.

Although there are no other regularly shipping mines at present in this district, yet there are several very promising prospects on Landlock Bay, Fidalgo Bay, Boulder Bay, Orca Bay, and on the mainland within a few miles of Valdez, the supply centre, situated at the head of Prince William Sound.

In the interior from Valdez some 160 miles or so are situated the Copper River occurrences of chalcocite, bornite, and other copper ores which have during the past few years attracted so much attention that at the present time a railroad company is preparing to construct a line into the Copper River district.

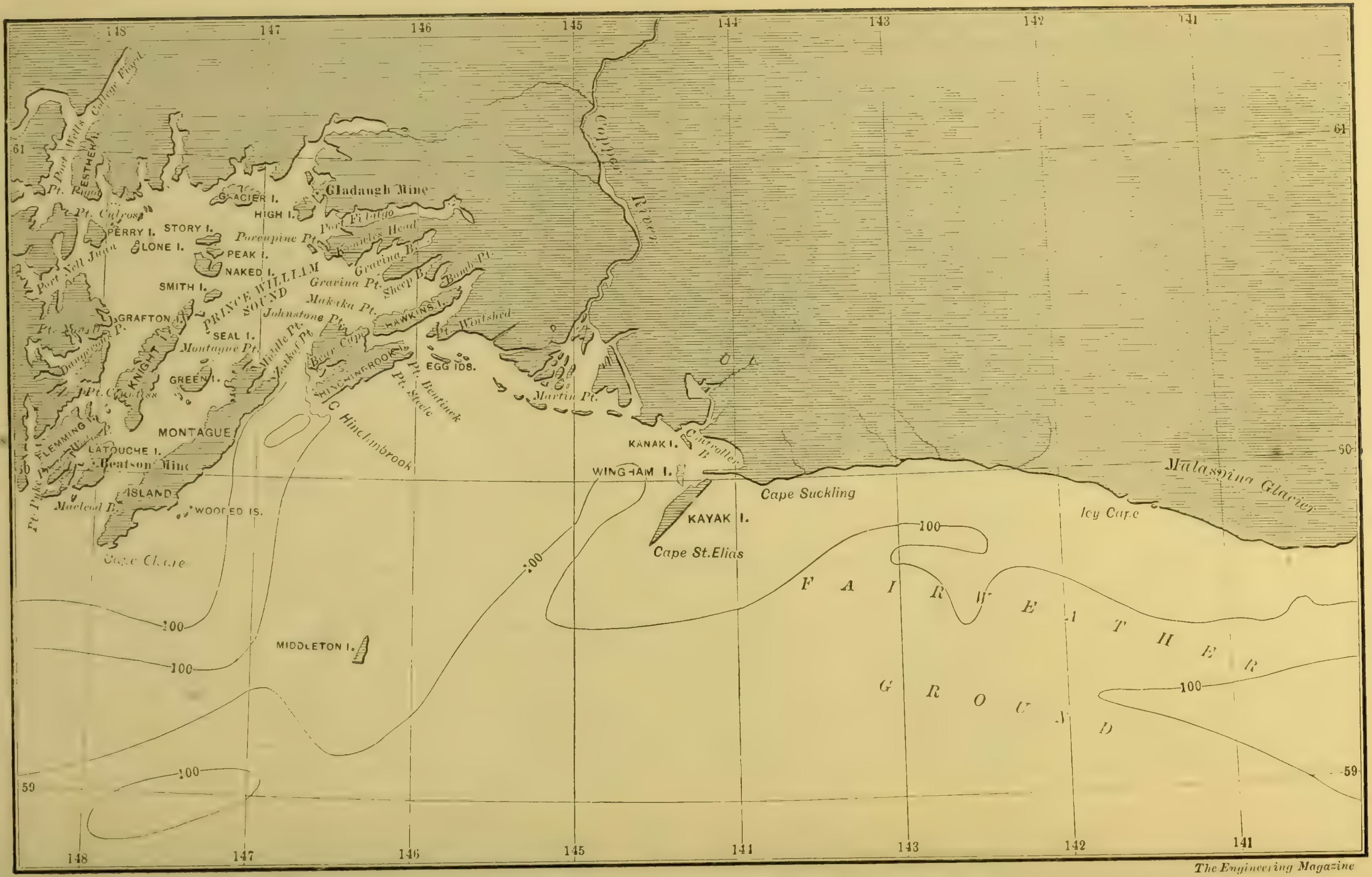
Kenai and Alaskan Peninsula Districts.—To the westward from Prince William Sound along the coast several very promising prospects have been located, some near Seward, the southern terminal of the Alaska Central Railway, others at Port Dick and Port Chapman, near the easterly side of the entrance to Cook's Inlet, and still others

GLADHAUGH COPPER MINE, ELLAMAR, ALASKA.

SEWARD, ALASKA, SHOWING THE TRACK OF THE ALASKA CENTRAL RAILWAY CONNECTING THE WHARF WITH THE TOWN.

in the vicinity of Illiamna Lake on the western side of this entrance. The ore occurring on these prospects is a copper-gold sulphide, carrying (it is claimed) high values, but on none of the prospects has there yet been sufficient work done to warrant an estimate of tonnage of ore in sight. Indeed, during the last season the first really earnest, systematic development work has been performed.

Prospectors during 1904 carried their explorations in search of copper-gold ores to the westward as far as Kadiak Island, and some locations were made; but owing to the remoteness and consequent difficulties in transportation, there being only one boat a month direct from Seattle, the owners of these prospects have found difficulty in



The Engineering Magazine

A PART OF THE MIDDLE ALASKAN COAST.
From the chart of the Coast and Geodetic Survey.

LANDLOCK BAY, PRINCE WILLIAM SOUND, ALASKA.

interesting capital; for this reason assessment work only has been performed.

The building of the Alaska Central Railroad from Seward is proving to be an encouragement to prospectors to explore the country along its route. This has resulted in the location of several gold-bearing quartz claims in the vicinity of Kenai Lake, some twenty miles from the town of Seward. Several very fine specimens of quartz showing free gold were brought out from this section late in the season, and the probabilities are that some systematic development will be attempted this year.

An occurrence of copper-gold known as the Ready Bullion group of mineral claims is situated some sixteen miles from the proposed line of the Alaska Central Railroad, on Turnagain Arm at the head of Cook's Inlet. During the season of 1905 considerable development work was performed on this property, with the expectation of blocking out ore ready for shipment when the railroad is completed sufficiently near to warrant building a branch to this property.

The vicinity of Turnagain Arm has been the scene of considerable placer and hydraulic mining since 1897, and every year some three or

PRINCE WILLIAM SOUND, NEAR THE ENTRANCE TO LANDLOCK BAY.

four hundred men have been employed in this industry. During 1904 and 1905 several companies took in heavy machinery for hydraulic mining, and during the present season these companies should be in a position to demonstrate whether or no their operations will result in commercial success.

This portion of Alaska has been handicapped in the past because of transportation difficulties. A 52-foot tide is not an unusual occurrence on Turnagain Arm; consequently navigation, especially in small boats such as are used by prospectors, is hazardous in the extreme, but with the advent of the Alaska Central Railroad into this portion of Alaska many of these transportation difficulties will be overcome.

The coal mining and prospecting for oil industries are carried on on the mainland near Kayak Island; also on the Kenai Peninsula and near the coast on Illiamna Bay; but owing to the remoteness of the districts the coal mines have not yet reached the point of production on a commercial scale, nor has any oil been shipped.

That portion of Alaska along the coast westward from Sitka undoubtedly possesses great wealth in mineral resources which will in the near future be developed to a point that will insure commercial success to many of the operators.

INDUSTRIAL DEPRESSIONS, AND ENGINEERING EXPORT AND IMPORT TRADE.

By W. Pollard Digby.

"There . . . . goes England's commercial prosperity." The Devil's Thoughts.—S. T. Coleridge.

The problem of the causes of great fluctuations in national prosperity is one of perennial importance, and Mr. Digby's graphic methods of examination are well worth following, at a time especially when the two greatest manufacturing countries—America and England—present extraordinary contrast in the point of industrial exaltation or depression.—THE EDITORS.

IT is perhaps questionable whether a writer on a statistical or economic subject should use as a prelude to any writings on subjects of gravity and far-reaching importance, any such preface as that which has been selected in the present instance. Its very appositeness seems so appropriate to the subject that, despite the unconventionality of the procedure, I have annexed it to serve very much in the nature of an illustrative text, or comment, on a popular and recurring interpretation of the statistical history of an important section of the industries of the arch manufacturing country of the world. The trite saying cited has been repeated—in effect, if not in identical wording, in each of the recurring depressions which have afflicted British industries. This quotation from a crude piece of doggeral semi-political, scathingly sarcastic, but soundly humanitarian in one stanza, has been preserved for posterity like a fly in amber only by reason of the abiding worth of Coleridge's other more valuable contributions to our literature. That British commerce is in a parlous condition, that like the pig drifting down the stream in the squib referred to, it is cutting its own throat, has been told in effect to us and to our forefathers with such reiteration that the British manufacturer is apt to become sceptical of oft-repeated warnings of impending disaster.

At the nadir of each cycle of depression, it is acclaimed that never were matters so alarming. The effect of this pessimism on a large population who do not trouble to go deeply into any such question as economic history, is enhanced to a very large extent by the advocates of numberless practices and policies. The educational reformer, the temperance advocate, both of whom preach more or less fruitlessly in a time of prosperity, find, in a time of depression, both an example and listeners. Here also is the opportunity of the demagogue and agitator. We are told, in effect, by disinterested and interested advisers alike, that hardly ever were matters so bad, and never was the future so dismal. To a small extent houses are set in order, extravagances are checked, methods of manufacturing are improved. Trade flows again in its old channels or in new, in a volume greater than before. Then the familiar features of prosperity manifest themselves—extravagance, over-production, reduced employment, perhaps a few bad harvests—and again the voices of the physician and of the quack, of the philosopher and of the mountebank, are heard in the land. If, ere the zenith of a trade cycle was attained, attention were paid to our more glaring defects of education, and to improving commercial methods generally, the subsequent period of depression would probably be less serious in its effects, although, of course, not entirely eliminated.

I have been led to compile the following notes by reason of the fact that in connection with the Protectionist movement undue emphasis is laid on exports and imports. Diminishing or stationary exports, together with increasing imports, are regarded as taking the bread out of the mouth of the artizan by the foreign manufacturer. If this state of affairs were as true as its narrators would wish their hearers to believe, we should expect to find the following phenomena:—

1.—With an increase in the exports of any particular industry the number employed in the industries concerned should increase; that is to say, the percentage of unemployed should be reduced *in proportion to the increase in exports.*

2.—With an increase in the imports of any particular industry, the number employed in the industries concerned should decrease; that is to say, the percentage of unemployment should be increased *in proportion to the increase in imports.*

Unless both these theorems are vindicated by the figures in the large majority of instances, they are surely untenable and should no longer be advanced by any participants in the present fiscal controversy.

In common with all other students of the fiscal question, I have found much of instruction and interest in the two "enquiry" blue books on "British and Foreign Trade and Industrial Conditions" (Nos. Cd. 1761 and Cd. 2337). The second of these publications gives an invaluable record of the course of employment in the United Kingdom for a number of years. The statistics of employment furnish a useful test "of the fluctuations of industry as a whole, inasmuch as they measure the relative activity and depression of the whole of the industries to which they relate, including production for the home market as well as for export." These statistics are therefore an index to two books; the one, compiled with great care and elaboration, deals with external trade, with a microscopic detail which enumerates commercial transactions of imperial importance, such as the imports of £10 worth of calcium carbide from the United States, or £3 worth of gum arabic from Victoria, or exports of steel girders to Queensland valued at £17, or sugar candy valued at £20 to the Bermudas or £5 worth of safety matches to Bombay.

The other book is an unwritten one, and, being unwritten, the state of affairs which it would narrate is often regarded as non-existent. Certain factors in import returns—such as imports of iron ore, or raw cotton, or wool—indicate to a partial extent the contents which the unwrittetn volume might contain. In its ideal form it would contain an account of the number of hands employed in each clearly defined industry, the amount of wages paid to them, the value of machinery, building, and site, the value of raw material dealt with, and the value of the finished output. Present statistics of railway traffic, savings-bank returns, and so forth, would be included. As a contribution to a settlement of the fiscal question, the contents of supreme importance would be those dealing with the consumption of raw material, and the output of finished articles. By balancing exports and imports of any particular class, and allowing for goods warehoused, an exact national balance sheet would be available so far as that section of industry was concerned. The solution of one aspect of the fiscal question would then be a matter of almost arithmetical simplicity—a simplicity which would appeal to the man in the street who, on the one hand, mistrusts brilliant metaphysical reasonings, and, on the other hand, cares as much for the elements of political economy as he does for the conservation of energy or the Carnot cycle. To the plain man wanting plain figures, statistics which contrasted exports and imports of a particular industry with the value of the home output, would show at once how far home industries were being ruined by dumping from abroad.

Among the staple British industries declared to be threatened are those of the engineering trades. Such announcements do not take into consideration the elementary facts which may be obtained from census abstracts on the one hand, and statistics of pig iron on the other. Let us look at a few data:—

Census Year.	Number per 10,000 of population engaged in iron and steel industries, and in producing manufactures thereof.	Production of pig iron per 1,000 employees in entire industry.	Consumption of pig iron per 1,000 employees in entire industry; production plus imports, minus exports, divided by number of employees.
1881	239	9,765	8,052
1891	257	7,730	6,827
1901	301	6,348	5,832

It happens by a singular chance that the census years happen to be years in which the general percentage of unemployment for all unions in the engineering, shipbuilding, and metal trades was about equal, being as follows:—

1881 3.8 (reckoned from monthly numbers of unemployed).
1891 4.4 (“ “ “ “ “ “).
1891 4.1 (partly computed from expenditure on unemployed benefit).
1901 3.8 (“ “ “ “ “ “ “).

While the percentages of total unemployment in the engineering trades remained constant, the number of artizans so engaged had increased more rapidly than the population as a whole. Yet the production of pig iron per 1,000 employees has declined by over 30 per cent, and the consumption by nearly 30 per cent, in twenty years.

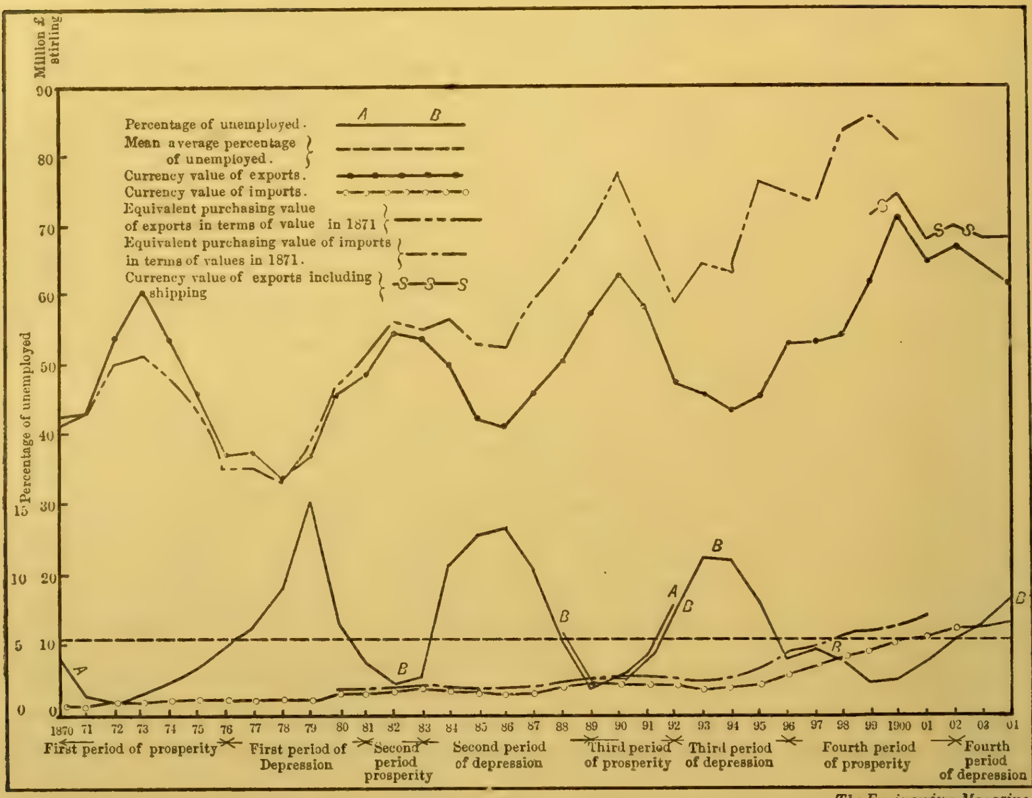
The foregoing figures are surely sufficient proof that the artizans engaged in these engineering industries are being diverted from the lower grades of work (23 per cent of the cost of pig iron being wages outlay in its conversion from ore to pig) into the more highly skilled branches of employment such as shipbuilding, in which the wages outlay in the shipyard is from 33 per cent to 40 per cent of the cost of the ship. There are those who contrast a stagnation of British pig-iron production with the notable increase in Germany and American production. These contrasts are made in ignorance—pretended or real, but certainly inexcusable—of the application to deposits of mineral wealth of the adage respecting eating one's cake and having it. We have had repeated scares regarding the duration of British coal supplies, and two Royal Commissions have reported reassuringly on the subject. As regards iron-ore, imports have grown without public perception or perturbation. Deposits of high-grade ore in readily accessible positions had gradually become exhausted. British capital found other sources in the Biscayan Provinces of Northern Spain, organized steamship services, and the state of affairs which resulted, is indicated in the following figures:—

Average for five years ending	1877.	1882.	1887.	1892.	1897.	1902.
Tons of ore imported into the United Kingdom per 100 tons of pig iron produced..........	12.4	27.7	40.2	50.2	61.2	70.7
Tons of ore imported into the United Kingdom per 100 tons of pig iron exported...........	78.2	129.6	262.6	388.6	507.8	544.0

The British iron industry, in stress of competition with other countries such as Germany, Belgium, and the United States, which had not drawn so largely on their ore reserves, evolved into an industry on a higher plane, purchasing semi-finished products from abroad, converting them into more highly finished goods of greater value. Great Britain thus finds more employment for her growing population by converting one ton of imported iron or steel into goods of greater value, than by making and exporting one ton of the crude material which, being the finished article of blast furnaces, is the raw material for other industries.

In considering the relation which exists between engineering imports and exports and the percentage of unemployment in the engineering industries, the question arises as to what should be selected as the initial year of computation. As the period of the early seventies has been often regarded as the golden era of British commercial supremacy, it is perhaps better to take 1870 as the starting point. The exports whose totals are indicated in the accompanying diagram comprise:—railway rolling-stock, electric-lighting apparatus and machinery, hardware and cutlery, sewing machines, steam engines, machinery and millwork of all descriptions, iron and steel in various form from bolts to tinplates, from girders to steel rails, from anchors to galvanized corrugated sheet. Copper and other metals are included. The imports are not so diversely classified, and the title "Total value of iron and steel imports and machinery" serves to indicate their scope. Their extent remained practically stationary over a long period, rising into prominence only during the past decade or so. From these exports iron ore has been excluded, for the obvious reason that none would question its being a raw material. On the same account copper (ore precipitate and regulus, as well as wrought and unwrought copper) pig and sheet lead, block, ingot bar and sheet tin, as well as crude and manufactured zinc, are also excluded. A purist with regard to classifications would justly catalogue a large number of the iron and steel imports as raw material. For instance, pig iron, which is the finished product of the blast furnace, is the raw material of the steel founder; steel billets, ships' plates, steel forgings, and other materials are but intermediate links in the manufacture of goods from a low to a higher stage. The finished product of one section being the raw material for other sections, the drawing of a dividing line is an impossibility, and the best description of these imports would be to describe them as finished and semi-finished.

As regards the condition of employment, the figures from the



The Engineering Magazine

TRADE DEPRESSIONS IN RELATION TO ENGINEERING EXPORTS AND IMPORTS.

second "Enquiry" blue book concerning the percentage of unemployment in the engineering, shipbuilding, and metal trades are taken as the standard. These cover only total want of employment, and not the partial lack of employment due to working short time. A glance at the accompanying diagram shows that the occasions of rising exports, reckoned in their currency value in pounds sterling, coincide fairly closely with a fall in the percentage of unemployed, and that the contrary state of affairs is manifested when exports are reduced in volume, as then the percentage of unemployed increases. Starting from 1870 we find a fall in the percentage of unemployment until 1872; the previous flood mark of depression had been in 1868. In 1873 the percentage of unemployment began to rise, and this rise continued until 1879, when the serious percentage of 15.3 was recorded. The number out of work then fell to 2.3 in 1882, and, turning again, rose to 13.5 in 1886, receded to 20 in 1889, rose to 11.4 in 1893, fell to 2.4 in 1899, and rose without set back to 8.8 for 1904.

If we were to take these turning points in the ebb and flow of employment as being the starting points of periods of prosperity or privation, we should not obtain a fair delimitation of these periods. If we take a period of increasing employment, such as that between

1894 and 1899, our next period of decreasing employment would contain the years 1900 and 1901, in each of which (although employment was decreasing) the percentage of unemployed was less than 1898. The fairest course will therefore be that of taking the arithmetical mean for 1870 to 1903 inclusive, and treating as periods of prosperity those in which the percentage of unemployment was below the average, and as periods of depression those in which the percentage of unemployment is equal to or above the average. For the engineering trades, this average during the thirty-four years mentioned stands at 5.6 per cent. This gives us the following classification:—

(a)	First period of prosperity	lasting until the end of	1876—	7 years.
(b)	First period of depression	“ “ “ “ “	1880—	4 “
(c)	Second period of prosperity	“ “ “ “ “	1883—	3 “
(d)	Second period of depression	“ “ “ “ “	1888—	5 “
(e)	Third period of prosperity	“ “ “ “ “	1891—	3 “
(f)	Third period of depression	“ “ “ “ “	1895—	4 “
(g)	Fourth period of prosperity	“ “ “ “ “	1901—	6 “
(h)	Fourth period of depression continuing at end of 1904 and covering up to that date......................			3 “

The accompanying diagram gives at a glance the value of imports and exports expressed in their currency and equivalent purchasing values in each year, together with the percentage of unemployed in the engineering trades unions in each year. The following table shows the relation between unemployment, the currency value of imports and exports, and the relative purchasing value during each of the eight periods defined above:—

Period (inclusive years).	Character.	Average percentage unemployed.	Average annual currency value of engineering exports.	Average of equivalent purchasing value of exports based on prices ruling in 1871.	Average annual currency value of imports of iron and steel machinery.	Average of equivalent purchasing value of imports based on prices ruling in 1871.
			£	£	£	£
a. 1870-76	Prosperity	2.7	48,549,000	44,951,000	2,045,000	1,906,000 p.
b. 1877-80	Depression	9.3	38,907,000	39,312,000	2,871,000	2,904,000 d.
c. 1881-83	Prosperity	2.9	52,758,000	54,458,000	3,895,000	4,036,000 p.
d. 1884-88*	Depression	9.8	46,361,000	57,698,000	3,546,000	4,288,000 d.
e. 1889-91	Prosperity	2.9	59,723,000	72,685,000	4,484,000	5,433,000 p.
f. 1892-95	Depression	9.3	47,206,000	61,595,000	4,098,000	5,368,000 d.
g. 1896-1901	Prosperity	3.6	60,009,000	79,678,000	8,842,000	11,833,000 p.
h. 1902-1904	Depression	6.8	64,507,000	....	....	....

While currency values provide in some cases a fairly accurate basis for comparing consecutive years, to make use of these in contrasting periods widely separated is an impossible procedure for those setting any store on accuracy. Even to compare the currency value of exports of pig iron in 1871 with those of 1873 would be entirely fallacious, as in the latter mentioned year the price received was double that in 1871. I have therefore fallen back upon the Board of Trade index numbers of forty-five chief articles of commercial value, and taking the purchasing value of the pound sterling in 1871 as 1.00, have expressed the relative values of the exports and imports dealt with in terms of the purchasing value ruling in 1871.

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* The year 1888 marks a change in method of computing percentage of unemployment. On the old basis this would have been an average year, but on the new basis of computation, the percentage is in excess of the average.

In the first period of prosperity the average percentage of unemployed stood at 2.7, and the average annual currency value of exports at £48,549,000. In equivalent purchasing value on the 1871 basis the average annual exports would be worth £44,951,000. The average imports were worth in currency £2,045,000, and in purchasing value £1,906,000. The first period of depression had an average percentage of employment of 9.3, and export currency value of £38,907,000. A large currency fall of £9,500,000 was masked by the general fall in the prices of commodities, the relative purchasing value standing at £39,312,000, or rather over £5,500,000. The second period of prosperity had an average percentage of unemployment of 2.9, a currency increase of exports of nearly £14,000,000, to £52,758,000, and purchasing-value increase of over £15,000,000 to £54,458,000. Imports rose as regards their currency value to £3,895,000, and as regards their purchasing value to £4,036,000. The second period of depression was marked by a rise in unemployment to 9.8 per cent and a fall of £6,500,000 in the currency value of the engineering exports to £46,361,000. The currency value of the imports fell to £3,546,000. So great, however, was the fall in the value of commodities generally, that the relative purchasing value of the imports rose to £4,288,000. The next period of prosperity—the third in the period under review—was marked by the return of the percentage of unemployment to 2.9, and by the great increase in exports, which had an average currency value of £59,723,000, and a relative purchasing value of £72,685,000. The imports rose as regards their currency value to £4,484,000, and as regards their purchasing value to £5,433,000. The third period of depression had an average percentage of unemployment of 9.3, and a fall of £12,500,000 to £47,206,000 in the currency value of the exports, while their purchasing value fell £11,000,000 to £61,595,000. Imports fell by about 10 per cent in currency value to £4,098,00c, but only by about 1 per cent in relative purchasing value, to £5,368,000. The fourth period of prosperity had an average percentage of unemployment of 3.6, and a rise of about £12,750,000 in the currency value of exports to £60,009,000. More remarkable is the rise of £18,000,000 in the purchasing values of these exports to £79,678,000. Imports rose to the high figure of £8,842,000 sterling in their currency, and to £11,833,000 in their equivalent purchasing value.

As regards the fourth wave of depression the figures are at present incomplete. One hopes that it has reached its worst feature, and present indications seem to point in this direction. The unemployment curve has not yet taken the desired downward trend, but judging from previous precedent it may fall from its high figure of 8.8 per cent in 1904 to a figure below the mean average line which I have arbitrarily taken as defining a border between prosperity and depression. One feature of the last period may be noticeable, and that is that while exports are slightly lower than the high-water mark of the previous period, the average for the past three years—although of increasing unemployment—is in excess of any previous period. Imports have remained practically stationary.

Reviewing the facts which have been elucidated by my figures, and which are illustrated in the accompanying diagram shewing the fluctuations in individual years, and in the preceding table which gives the average in the four sets of alternate periods, we find that:—

1.—In periods of depression, exports fell three times and rose on one occasion in their currency values; exports fell twice in their relative purchasing values, and rose on two occasions; and in periods of prosperity exports rose on each occasion as regards both currency and purchasing values.

2.—In periods of depression, imports rose on only one occasion in their currency values, fell twice and once remained practically stationary; rose twice in their purchasing values, remaining almost stationary twice; and in the periods of prosperity, imports always rise in regard to both their currency and purchasing values.

That is to say, that the two theorems which would require to be vindicated by the facts of the case are only partially vindicated by an examination of the figures of trade to which the ultimate appeal must be made. The reduction of particular classes of imports, which (it is asserted by unthinking advocates of a changed fiscal system, is all that is wanted to give universal satisfaction) would be of little real value to the engineering industry as a whole.

Of course, changes in the rate of employment are not bound up inseparably with external trade. The unchronicled and dimly realised volume of internal trade dependent upon home and foreign harvests of grain, dependent partly on rainfall in pastoral countries, on yield of wool, or raw cotton—all these are forces bearing upon the employment afforded in the engineering trades. There are also indirect engineering exports to be considered, such, for instance, as the cotton trade, whose export trade consists in the working up of imported raw materials, the receipts from which, after paying for raw material, have to cover wages to the operatives and wear and tear on machinery. These all have their bearing in the alternating waves of trade cycles, with their recurring times of surplus and scarcity.

An absolute elimination of periods of depression and prosperity is impossible. Nature from the opening bud to the flowing spring and neap tides, which occasion variations in the strata of the sediment deposited at our river estuaries, knows nothing of a straight-line law of operation. As the late Herbert Spencer has shown, rhythm prevails through all known forms of motion or progress. In the currents of commerce it (a backward and forward movement) "is especially conspicuous." "If . . . we turn to production and consumption we see undulations, much longer in their periods, but almost equally obvious. Supply and demand are never completely adapted to each other; but each of them from time to time leads presently to an excess of the other." Concluding a striking and suggestive chapter, Mr. Spencer* says, "Rhythm is a necessary characteristic of all motion. Given the co-existence everywhere of antagonist forces—a postulate which, as we have seen, is necessitated by the form of our experience—and rhythm is an inevitable corollary from the persistence of force."

The preceding chapter to that just quoted may be commended to all who imagine economic questions, such as the present fiscal controversy, can be solved by an enumeration of two phases of the case and assuming that these are the only factors involved.

Exports and imports are only a manifestation of the influences which bear upon our trade, both external and internal, directing it into one channel or another, or limiting a continuous expansion. Fluctuations are as inevitable as the seasons. To treat the economic question of lack of employment as summed up by a dumping of foreign goods, or a restricted access to foreign markets, and dirigible by tariff impositions, is to invest an intricate problem with an air of spurious simplicity, fraught with grave danger on account of its speciousness and superficiality.

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* First Principles, by Herbert Spencer, 5th Edition, p. 267.

CEMENT PRODUCTION AND MANUFACTURE IN THE UNITED STATES.

By Edwin C. Eckel.

The enormous rise in the per capita production and consumption of iron and steel has very recently been the subject of striking--indeed, almost sensational--comment. Proportionately little attention has been given to the even more enormous rise in the output of cement. Mr. Eckel lately sketched the principal outlines of this movement (see this Magazine for November, 1905) and now parallels his discussion of the American steel trade, which appeared in our last number, with a more detailed study of this companion and closely related industry.—THE EDITORS.

PERHAPS the most striking feature of the engineering and architectural practice of the present day, as compared with earlier work, is the extent to which steel and cement are employed, either together or separately, as structural materials. The general use of these two materials for such purpose is largely a matter of the past two decades, while some of their most striking utilizations have been determined only within a few years.

The growth of the steel and cement industries has of course paralleled the recent large extensions in the use of the finished products. In a recent number of this Magazine I have discussed the iron and steel industries in their general economic relations, while the present article will be devoted to the cement industry. Comparison of the two sketches would show a very remarkable—but very natural—parallelism between the periods of prosperity and depression in the two industries. This parallelism, of course, has been shown only during recent years, for the iron and steel industries date back to very remote periods in the history of the race, and have occupied an important economic position for many centuries.

In this connection it must be recalled that cements which will set under water are comparatively new products, having not much over a century of recorded use to their credit. Notwithstanding occasional statements to the contrary, the ancients had no knowledge of true hydraulic cements. Analyses of mortar material used in the construction of the Pyramids shows that it was composed of calcined gypsum, or plaster of Paris; and many other ancient mortars are of this type, being plasters rather than cements. Ordinary lime mortar, of course, has been in common use since very early days, and many of the famous Roman works were constructed with a mortar which an engineer of to-day would hesitate to use. Such common lime or "quicklime" is made by burning a pure limestone at comparatively low temperatures, just sufficient to drive off the carbon dioxide which it contains. The resulting product—quicklime—will slake violently if water be added to it, and when thus mixed with water and sand becomes the ordinary lime mortar of the builder.

Until late in the eighteenth century it was supposed that the purer, the limestone, the stronger the resulting mortar. About 1795, however, French and English engineers, working independently, found that when a very clayey impure limestone was burned a very interesting product was obtained. This new material was a true hydraulic cement, for unlike quicklime the burned lumps did not slake on the addition of water, but when ground up finely and then mixed with water the mortar possessed hydraulic properties— i. e. it would "set" or harden under water.

Natural Cements.—Cements made in this fashion, by merely burning a naturally clayey limestone and grinding the resulting lumps, are known as natural cements. Under the names of Parker's cement, Roman cement, etc., such natural cements soon became widely manufactured and used in England and on the Continent. In the United States they were first made in 1819, in New York State, and were extensively used in the construction of the first Erie Canal. The manufacture soon spread over the country, the incentive to this rapid adoption of a new industry being the necessity for using a hydraulic mortar in the locks and walls of the many canals then under construction. The various American natural cements are generally known to engineers by the name of the locality at which they are manufactured, as Rosendale cement, Akron cement, Fort Scott cement, Utica cement, etc.

The American natural-cement industry has shown very slight gains in annual output during the past decade, and at present is almost stationary. During the eighty-five years of its existence, however, the total amount of natural cement produced in the United States has been very large, and even now the industry can hardly be considered as being beyond hope. Improved methods of manufacture, and greater care on the part of the managers and chemists, would go far toward placing it on a thoroughly sound footing.

The localization of the natural cement industry in certain parts of the United States is well brought out in the following table. It will be seen that New York, the birthplace of the industry, still retains first rank, though by a steadily lessening margin.

State.	1902. Number of works.	1902. Quantity.	1902. Value.	1903. Number of works.	1903. Quantity.	1903. Value.	1904. Number of works.	1904. Quantity.	1904. Value.
		Barrels.			Barrels.			Barrels.	
Ga. ...	2	55,535	$31,444	2	80,620	$44,402	2	66,500	$37,750
Ill. ...	3	607,820	156,855	3	543,132	178,900	3	360,308	113,000
Ind. . .	15	1,727,146	869,163	15	1,533,573	766,786	13	735,906	367,953
Ky. . .							2	264,104	132,052
Kan. .	2	160,000	80,000	2	226,293	169,155	2	210,922	79,456
Md. . .	4	409,200	150,680	4	269,957	138,619	4	65,000	32,500
Minn. .	2	150,000	67,500	2	175,000	78,750	2	138,000	65,620
N. Y. .	19	3,577,340	2,135,036	20	2,417,137	1,510,529	19	1,911,402	1,138,667
N. Dak.	1	....	....	1	....	....	1	*a*	*a*
Ohio .	2	....	....	2	67,025	46,776	1	*b*	*b*
Pa. . .	6	796,876	340,669	7	1,339,090	576,269	5	770,897	298,533
Tex. .	1	....	....	2	....	....	1	*c*	*c*
Va. . .	2	34,000	20,000	2	47,922	25,961	2	93,292	59,619
W. Va.	1	88,475	62,655	1	....	....	1	....	....
Wis. . .	2	437,913	162,628	2	330,522	139,373	2	250,000	125,000
Total	62	8,044,305	4,076,630	65	7,030,271	3,675,520	61	4,866,331	2,450,150

The annual production of natural cement in the United States for the years 1890 to 1904 inclusive, was as follows:

	Barrels.
1890	7,082,204
1893	7,411,815
1895	7,741,077
1897	8,311,688
1898	8,418,924
1899	9,868,179
1900	8,383,519
1901	7,084,823
1902	8,044,305
1903	7,030,271
1904	4,866,331

This table is of particular interest when compared with a similar one, presented on the following page, giving the production of Portland cement for the same years.

Portland Cement.—The agency which has had most influence in checking the growth of the natural-cement industry has been the remarkable development of the manufacture of Portland cement. First made in England in 1824, and named because of the resemblance of the set cement to a well-known English building stone, the industry soon became important in England, France, and Germany. Until about 1875, however, practically no attempt was made to manufacture Portland cement in the United States; and from 1875 to 1890 the new industry grew quite slowly. From that date on, however, and

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a Included with Minnesota. *b* Included with Virginia. *c* Included with Kansas.

particularly since 1895, its growth has been surprisingly rapid. This is well shown in the following table, which gives statistics of the American production of Portland cement for the years 1870 to 1905 inclusive.

TOTAL PRODUCTION OF PORTLAND CEMENT IN THE UNITED STATES.

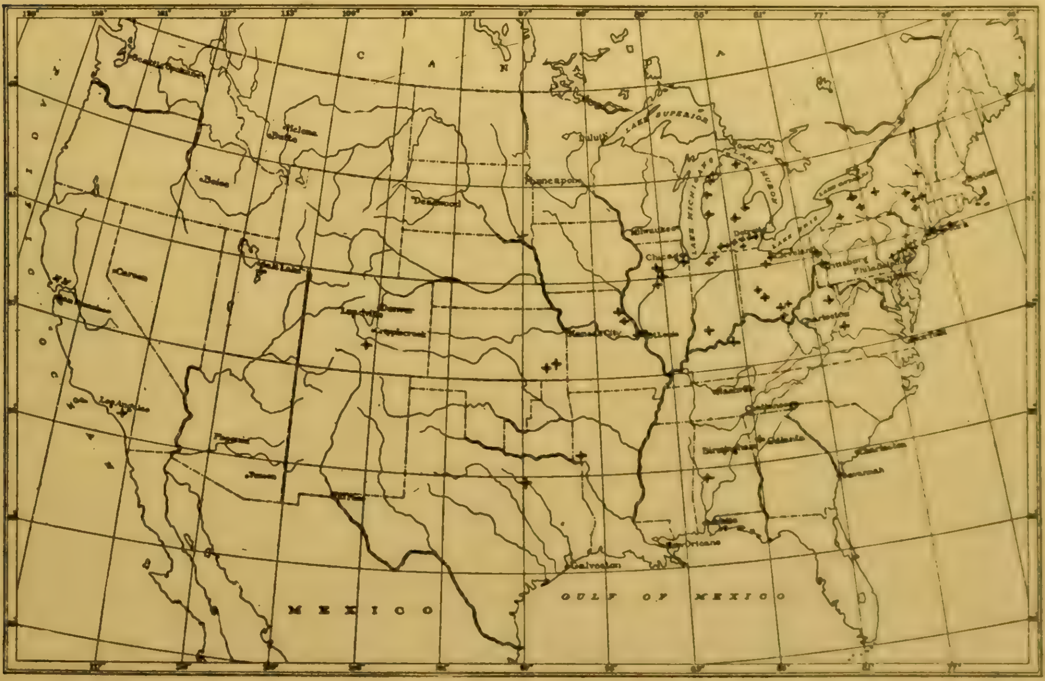
Years.	Plants.	Barrels.	Value.
1870-1879	..	82,000	246,000
1880	..	42,000	126,000
1881	..	60,000	150,000
1882	..	85,000	191,250
1883	..	90,000	193,500
1884	..	100,000	210,000
1885	..	150,000	292,500
1886	..	150,000	292,500
1887	..	250,000	487,500
1888	..	250,000	487,500
1889	..	300,000	500,000
1890	16	335,500	704,050
1891	17	454,813	967,429
1892	16	547,440	1,153,600
1893	19	590,652	1,158,138
1894	24	798,757	1,383,473
1895	22	990,324	1,586,830
1896	26	1,543,023	2,424,011
1897	29	2,677,775	4,315,891
1898	31	3,692,284	5,970,773
1899	36	5,652,266	8,074,371
1900	50	8,482,020	9,280,525
1901	56	12,711,225	12,532,360
1902	62	17,230,644	20,864,078
1903	71	22,342,973	27,713,319
1904	79	26,505,881	23,355,119
1905	82	31,000,000	29,000,000
Total................		138,114,577	$153,660,717

The detailed statistics for 1905 are, of course, not obtainable at this date, so that the figures given for that year in the above table represent merely my own estimate as to quantity and value of production. I believe that my estimate, if wrong, errs in being too conservative. The immense output of our mills for the last few months of 1905 may carry the total production for the year considerably higher than the 31,000,000 barrels which I have allowed. However the final figures may turn out, it is certain that the 1905 total is by far the largest ever shown by the American cement industry—and this in spite of a distinctly bad start for the year. Last winter most of the mills carried over large stocks, and the low prices which this caused in the spring had the effect of discouraging production. Late in the spring, however, the cement trade caught the same advance that made such an impression on the iron industry, and this condition lasted with little interruption until the present date. The year 1906 opens with practically every mill in operation at its full capacity, and with new mills being rapidly pushed to completion.

The materials used in Portland-cement manufacture are limestone and clay, in some of their many forms. These are mixed in proper proportions, the mixture is finely ground, and then burned almost to a slag, after which the semi-fused product or clinker is reduced to extreme fineness. This outline may seem simple, but the process is in reality one of extreme delicacy, requiring the greatest care throughout in order to insure a satisfactory product.

The idea seems to be commonly held that deposits of raw material suitable for Portland-cement manufacture are of extreme rarity, and therefore of great value. As a matter of fact, such materials are very widely distributed throughout the United States, and many other factors besides good raw materials have to be considered in deciding on the location of a plant.

Attention may here be called to a feature of particular economic interest—the utilization of the waste-products of other industries as materials for the manufacture of Portland cement. Among the by-products which have been successfully used in this manner are included blast-furnace slag, alkali waste, and the waste slate from quar-



MAP SHOWING DISTRIBUTION OF PORTLAND-CEMENT PLANTS IN THE UNITED STATES.

Except in southern Michigan and south-eastern Pennsylvania, each cross represents a single factory. In the two districts named the plants are too closely grouped to be shown separately.

ries and slate-dressing mills. Of the three named blast-furnace slag is of course the most important, and its successful utilization as a Portland-cement material is worthy of particular attention. The Clinton Iron and Steel Co. of Pittsburg first used it for this purpose, followed within a few years by the Illinois Steel Co. at Chicago. The latter plant has been so successful that it will probably result in a marked extension of this use of slag At present the American iron industry is in such a prosperous condition that it is difficult to convince its managers that such economies are desirable, but whenever a dull period sets in all are willing to find some profitable use for this by-product.

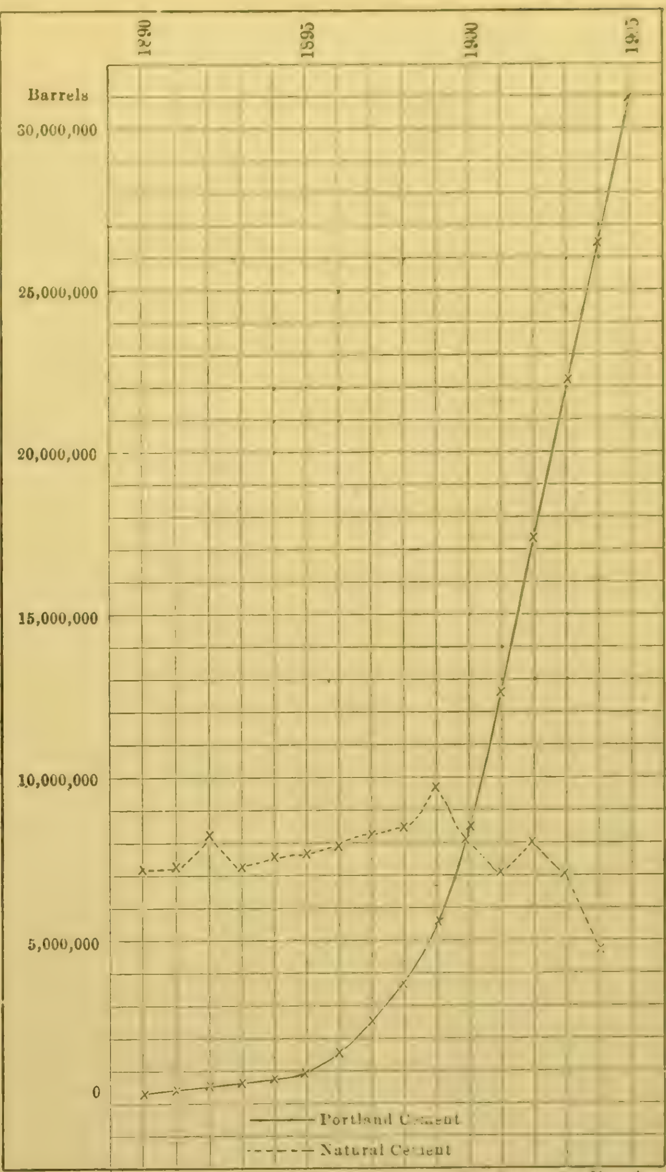
The distribution of the Portland-cement industry of the United States is shown in the following table, which gives detailed statistics for three recent years, and is brought out graphically on the map which appears on the preceding page.

	1902.			1903.			1904.		
State.	Number of works.	Quantity.	Value.	Number of works.	Quantity.	Value.	Number of works.	Quantity.	Value.
		Barrels.			Barrels.			Barrels.	
Ala.	1	....	....	1	....	....	1	....	....
Ark.	1	....	....	1	....	....	1	....	....
Cal.	2	294,156	$431,910	3	631,151	$1.019,352	3	1,014,558	$1,446,909
Col.	2	82,044	105,016	1	258,773	436,535	1	490,294	638,167
Ga.	0	....	....	1	....	....	1	....	....
Ill.	4	767,781	977,541	4	1,257,500	1,914,500	5	1,326,794	1,449,114
Ind.	3	536,706	628,244	3	1,077,137	1,347,797	4	1,350,714	1,232,071
Kan.	1	830,050	1,017,824	1	1,019,682	1,285,310	2	2,643,939	2,134,612
Mich.	10	1,577,006	2,134,396	13	1,955,183	2,674,780	16	2,247,160	2,365,656
Miss.	1	....	....	2	825,257	1,164,834	2	....	....
N. J.	2	2,152,158	2,563,355	3	2,693,381	2,944,604	3	2,799,419	2,099,564
N. Y.	8	1,156,807	1,521,553	10	1,602,946	2,031,310	10	1,362,514	1,257,561
Ohio	7	563,113	685,571	8	729,519	998,300	7	910,297	987,899
Pa.	15	8,770,454	10,130,432	16	9,754,313	11,205,892	17	11,496,099	8,969,206
S. D.	1	....	....	1	....	....	1	....	....
Tex.	2	165,500	234,950	1	....	....	1	....	....
Utah	1	....	....	1	....	....		....	....
Va.	1	334,869	433,286	1	538,131	690,105	1	864,093	774,360
W. Va.	..	....	....	1	....	....	1	....	....
Total	62	17,230,644	20,864,078	71	22,342,973	27,713,319	79	26,505,881	23,355,119

In the table above Alabama, Georgia, West Virginia, and Virginia are reported together; the products of Kansas and Missouri are given in combination; and Colorado, Utah, and Texas have their products combined. In each case the combined product is given in connection with the State which was the largest producer.

About three-fifths of the entire American production comes from a small area in southeastern Pennsylvania and western New Jersey, the so-called Lehigh district. As at present developed this district contains over twenty cement plants within an area about twenty-five miles long and four miles wide, and produces in the neighborhood of 20,000,000 barrels of Portland cement annually.

Reference has been earlier made to the fact that the Portland-cement industry started in the United States about a half-century after the manufacture of natural cement was commenced. The recent relations of the two industries are shown in the accompanying diagram. It will be seen that while natural cement has shown little advance in production during the fifteen years plotted, Portland cement has shown a surprising increase, and now far outdistances its competitor. In the past few years, however, improvements have been effected at certain natural-cement plants which seem likely to give a new life to that industry.



The Engineering Magazine

ANNUAL PRODUCTION OF PORTLAND AND NATURAL CEMENTS, 1890-1905.

Portland cement, on the other hand, has increased steadily and rapidly in output and use, and there seems no reason to believe that this increase will be materially retarded for many years. The product is being constantly employed for new uses, the most striking developments of the past few years being in the line of its employment with steel as reinforced concrete, and in the rapid extension of its use as an achitectural material in the form of concrete blocks.

Certain interesting features of the American cement trade are brought out by the following table of domestic production, imports and exports. It will be seen that while the imports have decreased little in absolute quantity, their relative importance has fallen off rapidly, while a small export trade is now in course of development.

Year.	U. S. Production. Barrels.	Imports. Barrels.	Exports. Barrels.
1890............	335,500	1,940,186	....
1893............	590,652	2,674,149	....
1895............	990,324	2,997,395	....
1897............	2,677,775	2,090,924	....
1898............	3,692,284	1,152,861	....
1899............	5,652,266	2,083,056	....
1900............	8,482,020	2,321,416	100,400
1901............	12,711,225	922,426	373,934
1902............	17,230,644	1,963,023	340,821
1903............	22,342,973	2,251,969	285,463
1904............	26,505,881	968,410	774,940

A modern Portland-cement plant, of American type, capable of turning out 2,000 barrels per day, would employ in its quarry and mill some 200 to 250 men. Of these at least four-fifths are unskilled laborers, while unionism has not taken serious hold anywhere among the skilled laborers, so that the industry has been fairly free from labor difficulties. Such a plant would probably represent an investment, including costs of land and plant, and working capital, of some $1,000,000 to $1,500,000. The cement industry is not one in which the manufacture can profitably be carried on in a small way, except in districts remote from competition, and the plant above cited can not be regarded as exceptionally large. It is evident, therefore, that the cement industry is not one for individuals or small companies.

On the other hand, the Portland-cement industry does not lend itself readily to any idea of monopoly. Proper raw materials are too common to permit this, for there is hardly a county in the United States in which cement could not be made, if prices were forced high enough to justify the undertaking. The American industry has so far been marked rather by too free competition than by the reverse, though at intervals the newspapers may inveigh against the enormous profits realized by a purely imaginary Cement Trust. Now, whatever may be said about monopolies and trusts, absolutely unrestricted competition is not desirable, and there are already signs that in some districts the cement plants have realized that a certain community of interest should exist. The development of this idea may be watched with some interest during the next few years.

APPLICATIONS OF PNEUMATIC POWER IN THE MACHINE SHOP.

By R. Emerson.

THERE was a general tendency during the Nineteenth Century toward the centralization of prime-movers and the operation of all classes of machinery by transmitted power. Among the most common systems of distribution are mechanical (shaft; rope, belt or chain); hydraulic, pneumatic, and electric. The mechanical distribution systems are costly to install, and somewhat cumbersome; their practical range is but a few hundred feet.

Hydraulic transmission is objectionable for general use because of the many leaks, and the problem of disposing of the "used" water. Pneumatic transmissions, unless carefully designed, are subject to water-condensation troubles and to invisible leakage. If proper care is exercised to install pipes and joints that do not leak, the practical radius of use (while not usually comparable in length to long-distance electric transmission) is very considerable; and in special cases the system has a number of advantages over electricity. The relative generating, transmitting and operative efficiency, in shops or works installations, or in small plants, is not in favor of electricity; although the costs of piping and wiring, for equal powers, are comparable, the initial costs of generators, *versus* compressors, of electric *versus* air motors, of transformers *versus* reservoirs (not to speak even of switchboards) are greatly to the advantage of the pneumatic equipment. The lack of danger in an air system has been cited,—an important feature in tools working in close quarters on metals; and the greater portability of the air tools now on the market compared with the electric contrivances thus far in general use in the United States and in Germany, is a point of advantage that every shop man (and shop men must use the machines) will vouch for. A further underlying advantage is that electricity is used practically to impart rotary motion alone, whereas air has an endless variety of uses. Thus it is that compressed air has found favor in mining, bridge and shipbuilding, structural steel work, in erecting-shop work; that in a recent large quarry installation it was preferred, though the lines ran two miles from the power plant; that in the early development of Niagara Falls as a power center, it was proposed to use compressed-

WORKING IN CLOSE QUARTERS.

air transmission, and that in British Columbia, at Ainsworth on Kootenai Lake, an automatic air-compressing plant is delivering compressed air to miners within a radius of several miles. Modern railroading, as a further instance, with its high-speed and heavy trains, would have been impossible without the air brake.

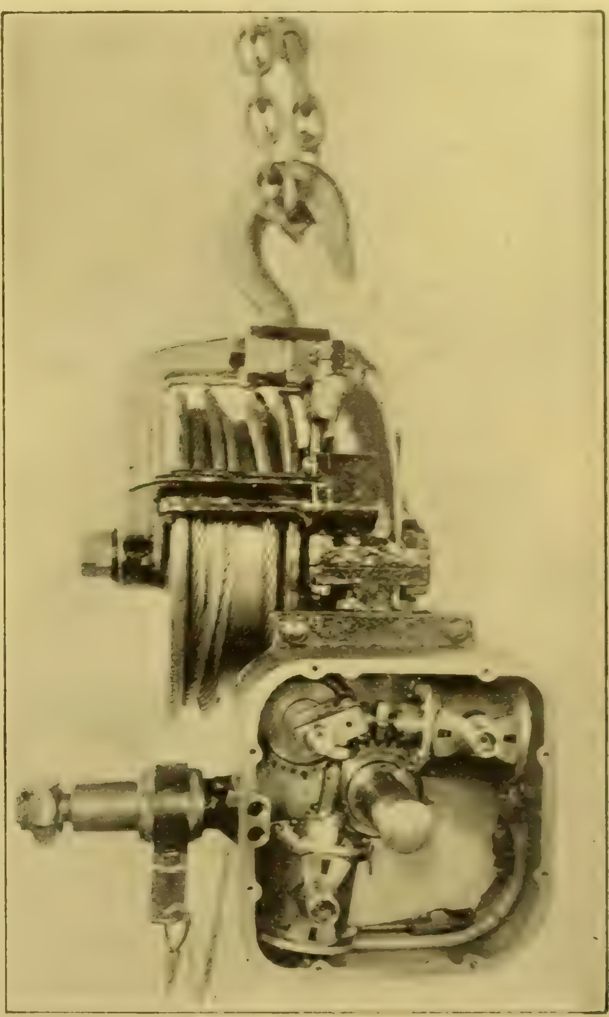
The great variety of uses to which air power can be put has made its development rapid and extensive and its effect on prevailing practices and methods has been so marked as almost to revolutionize every important line of modern engineering. Stone cutters, rock drillers, motors, hammers, yoke riveters, hoists, lifts, presses, carpet cleaners, sand blast, painting machines, conveyors, bolt nippers, jam riveters, flue cutters, holder-ons, air jacks, sand rammers, bell ringers, sand sifters, fire forges, brazing and welding flames — these are a few of the less well-known uses of compressed air.

Pneumatic and electric motors do not "generate" power; they turn into useful work the energy transformed through

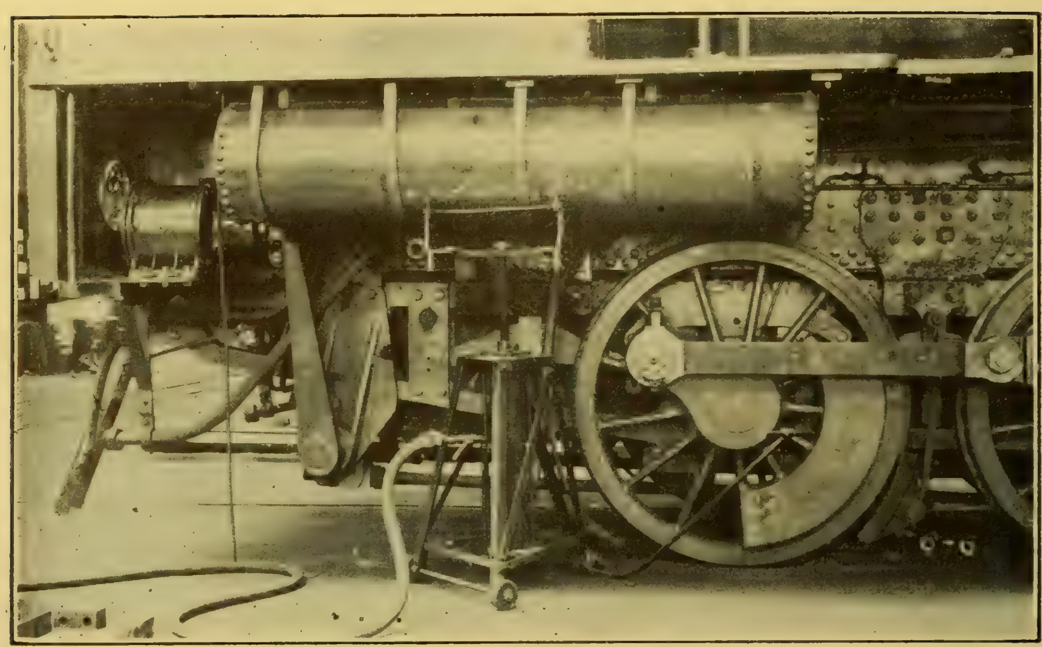
ONE MAN REAMING IN BOILER STEEL.

them. Both electric and pneumatic motors are of such recent development that many practices that ought to be obsolete still prevail, especially in railway shops, where competition does not exert the same stimulus as in commercial shops.

The shops of the immediate past had a main shaft driven by a Corliss engine. This shaft drove all the machine tools. There was either a mechanical or a hand crane—or none at all—over the erecting or assembling floor. Present practice drives generators direct by high-speed "automatic" engines; takes the current to large 20- or 30-horse-power motors (relegated to the rafters in the shops), each driving a "group" of machines, through main and countershafts, some heavy machines having individual motor-drive; and also installs an air compressor, reservoir, and piping, with motors and hammers for use on the floor and outside.

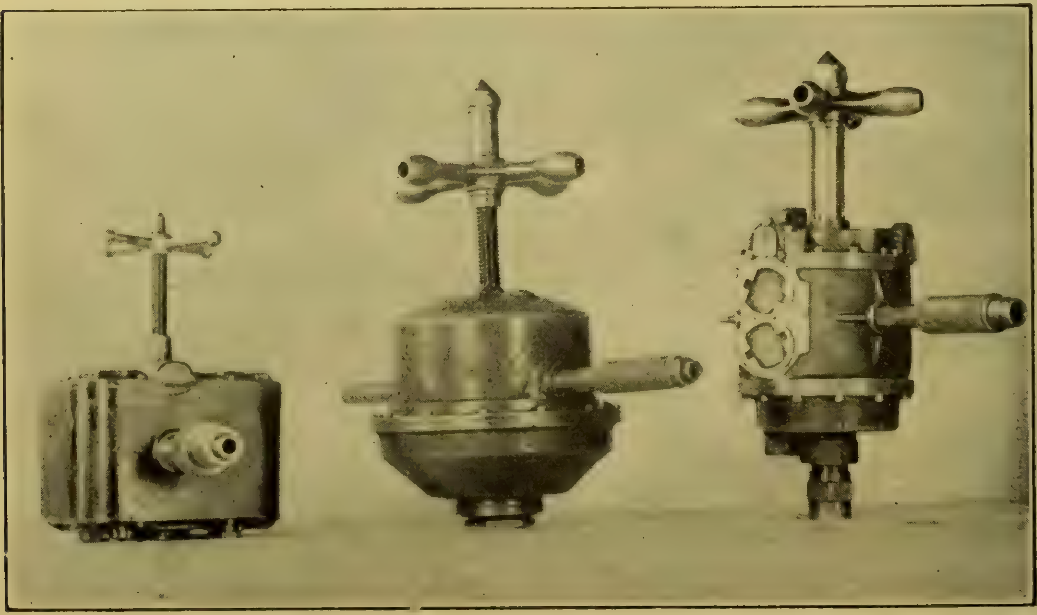

INTERNAL MECHANISM OF AIR HOIST, SHOWING THE SMALL PNEUMATIC ENGINES DRIVING THE WORM OF THE WORM GEAR.

While it is probable that individual and group drive will be retained much as at present, the impending advance in shop betterment with increase of capacity, indicates that many heavy operations will be done by portable tools (whether light electric or air, or the heavier electric-driven machines carried on trucks or transferred by crane) avoiding the effort of moving the mountain to Mohammed. It is this phase of the question that interests us, for it means a transformation not only of work done by hand to work done by power, but also transplanting of work done in the machine shop to work done on the floor, and the sav-



NEW METHOD OF JACKING AIR RESERVOIR WITH AN AIR-OPERATED DRUM-HOIST. IN MARKED CONTRAST TO THE OLD CUMBERSOME BLOCKING-UP.

ings and economies to be effected will be considerably greater than those obtained through individual or group electric machine-drives—greater even than those obtained by high-speed steels. For example: if it takes 14 hours to set up a job and 6 to do it, of which during less than 3 a high-speed tool is actually cutting, a saving of 10 or 12 hours might be realized by moving a portable tool to the part to be repaired or machined.



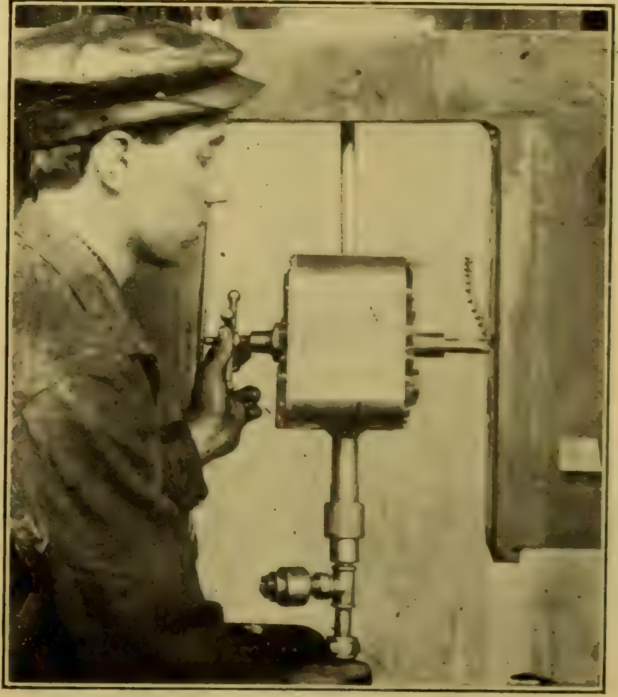
TYPICAL MOTORS, WITH FEED SCREWS EXTENDED.

A "HAND" JOB DONE BY AIR.
Drilling in a locomotive fire-door.

A few years ago (and even in some shops today) all drilling, tapping, chipping, calking, riveting, reaming, flue rolling, grinding of joints, cutting, beading, valve-seat facing, ramming, etc., was done entirely by hand, and there was no such thing as an air-lift to handle work for heavy machines; today all progressive shops are dependent on air for economical production.

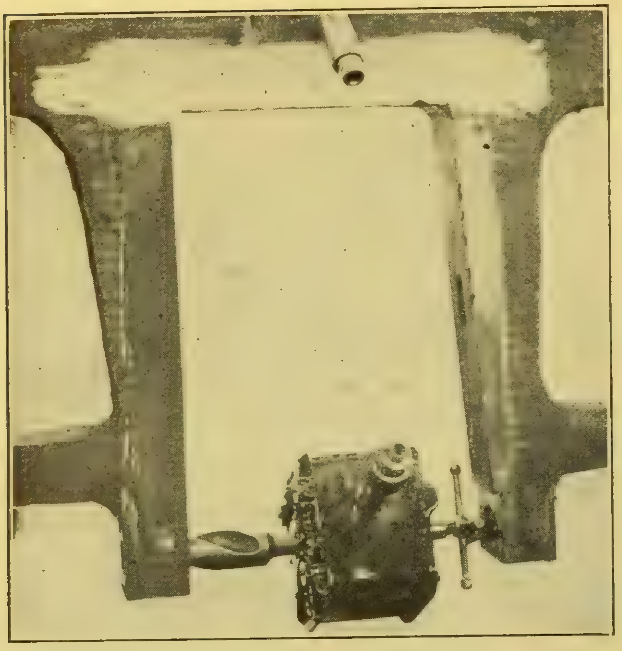
The Evolution of Motors into Modern Types.—Having a general conspectus of the field of work to which portable power-driven tools are applicable, it is interesting to note the recent development and improvement in design of these tools before passing to the consideration of intrinsic merits of modern types.

The earlier motors were heavy and unwieldy compared to those now in use. One of the first was the product of a boiler-shop foreman in a western railway shop. Later, an improved motor, and an air hammer, were developed. A young mechanic, seeing this hammer in operation and realizing its advantages in chipping cast-



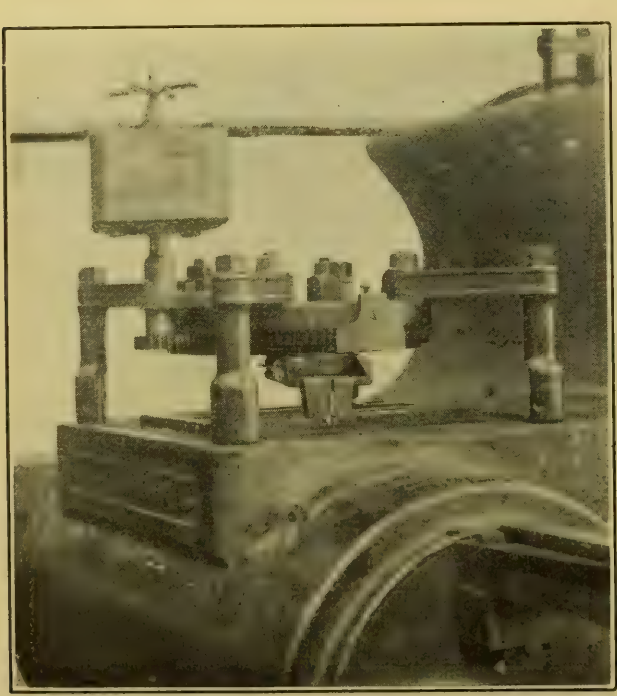
A "HAND" JOB IN NARROW QUARTERS.

ings, introduced himself to the inventor, who in a small shop employing four or five men, was making these tools.



DRILLING FOR PEDESTAL BOLT HOLES IN A LOCOMOTIVE FRAME.

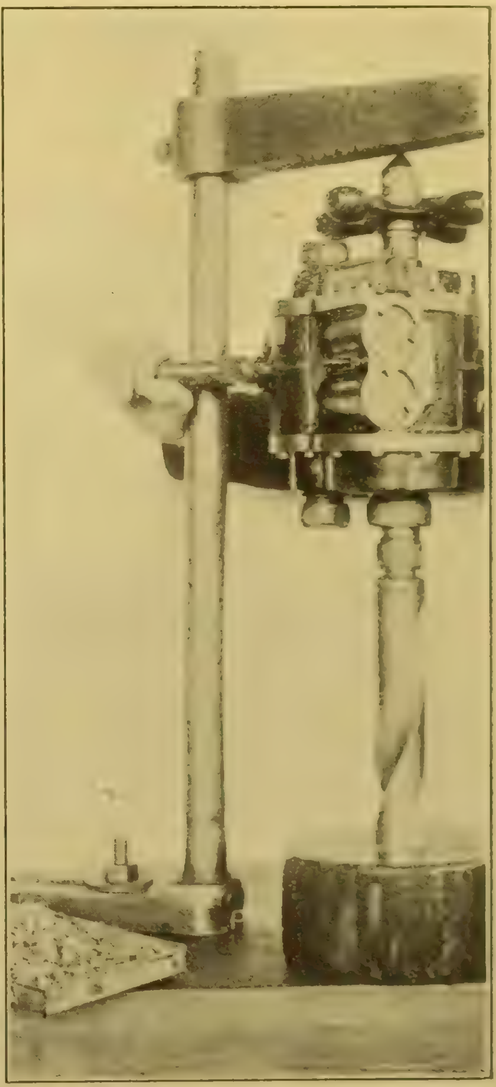
The mechanic, who was an able demonstrator, combined with this quality an unusually pleasing personality, great imaginative fore-sight, organizing ability. and unbounded enthusiasm. He agreed to take, and to sell, the entire product of the little shop. Within twelve months, the shop output had been increased manifold, and a few years later the inventor was enabled to retire with a large fortune. Great credit must be given to these pioneers through whose efforts this innovation was put into practical and economical use. It is no small achievement to change radically time-honored methods of the mechanical trades in the space of less than a generation, especially when it is realized that the machines in question were far from being perfect when they were first taken hold of by these men.



VALVE-SEAT-FACING ARRANGEMENT.

This brief sketch illustrates the newness of the air-motor as a practical machine, and its rapid extension to many lines of work.

The early motors were unwieldy and inefficient to such an extent that there was great difficulty in persuading men to use them. "Old men," dogs, braces, clamps, had to be rigged up before the machine could be used; but even with a helper (and the weight and vibration of the motor necessitated two men) the men were loth to employ air tools, because of the difficulty in handling. The average man on day work seeks not how quickly, but how easily, to do a job.



MODERN HEAVY DRILLING, WITH AN "OLD MAN."

Productive Efficiency in the Shop.—An air tool, however, like all other machinery, is intended as a help to the men and work, and not as a hindrance, so rival manufacturers have continually had before them the stimulus to make a machine that would not only do the work—do "hand" work in very close quarters—but that would also be easy and convenient to use—that would save, not increase, the man's effort. Realizing the necessity of securing the hearty and willing co-operation of the workers, shop officials have become more critical, have instituted tests of efficiency and power, of durability, and of economy of maintenance in proportion to weight, and these tests have thus reacted on the business of the manufacturers, forcing them by competition to improve their air tools.

As an instance of the interest and influence of users of air tools, a railroad official asked various manufacturers to submit their most efficient and useful machines for test. These and some six of the older type machines were thoroughly tested, at various speeds, under various loads, and with different air pressures. Gauge, meter, scale, and revolution readings were taken at half-minute intervals, and endurance tests of half a day were also carried out. From these tests, and from records kept of service of motors and of itemized repairs made to each machine, extending over a period of two years, the data in the accompanying diagrams are taken. Consequent upon the tests and their calculated results, orders were placed in several sizes for a number of each of the best machines.

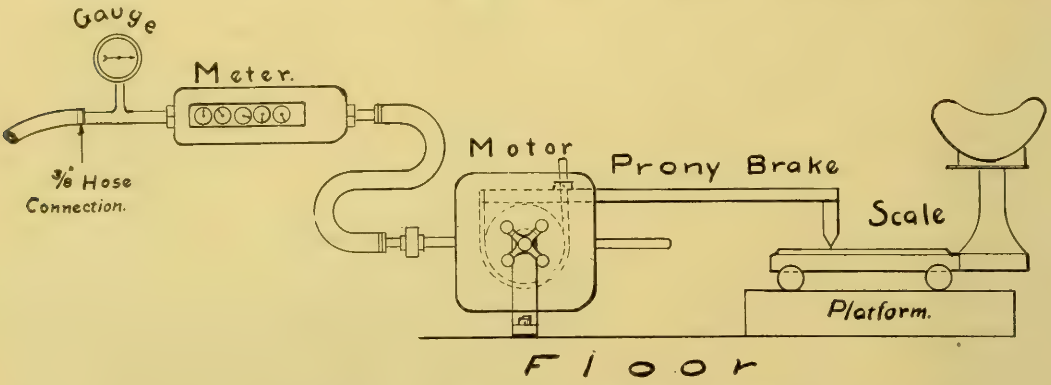
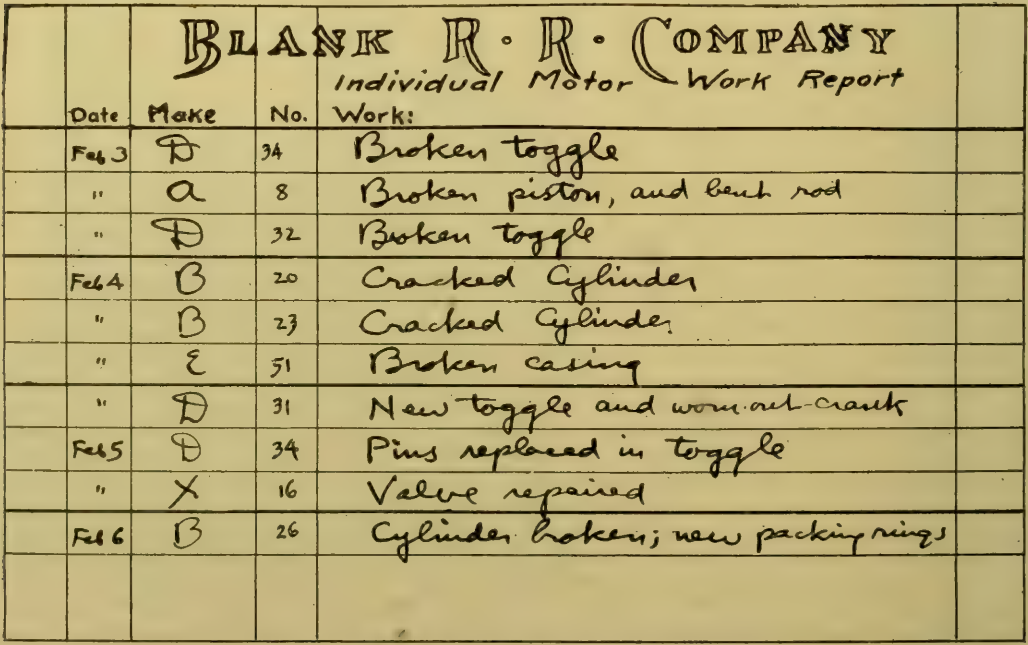


DIAGRAM OF METHOD OF TESTING MOTORS.

These machines, allotted to certain men and gangs in the shops, came at once into general favor, and owing to a rigorous system of inspection and repair (blank forms of the records of which are herewith shown), their efficiency was far higher than had been the case with the older machines, while the repair cost per hours worked fell below that of previous experience.

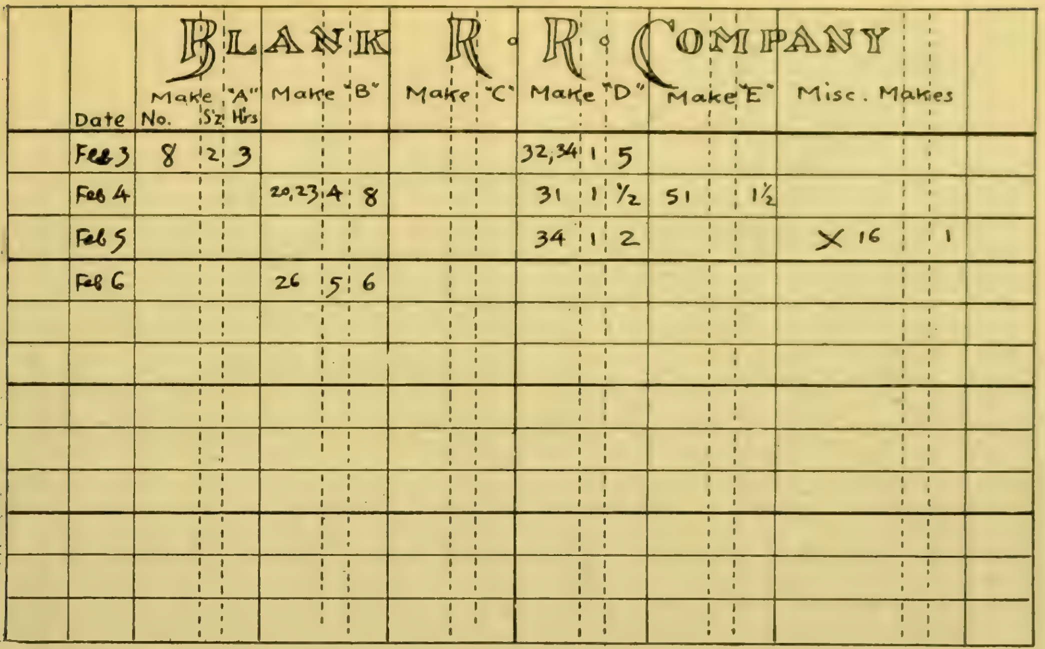
Certain of the machines were not assigned to definite gangs, but were for general use. The men who had need of a machine demanded one of the new ones. One make of machine was in particular favor because of its lightness. In fact, there were cases where men had to be disciplined for failing to turn in motors on Saturday night for in-



BLANK R. R. COMPANY
Individual Motor Work Report

	Date	Make	No.	Work:	
	Feb 3	D	34	Broken toggle	
	"	a	8	Broken piston, and bent rod	
	"	D	32	Broken toggle	
	Feb 4	B	20	Cracked Cylinder	
	"	B	23	Cracked Cylinder	
	"	E	51	Broken casing	
	"	D	31	New toggle and worn-out-crank	
	Feb 5	D	34	Pins replaced in toggle	
	"	X	16	Valve repaired	
	Feb 6	B	26	Cylinder broken; new packing rings	

FORM FOR RECORDING AIR-MOTOR REPAIRS.

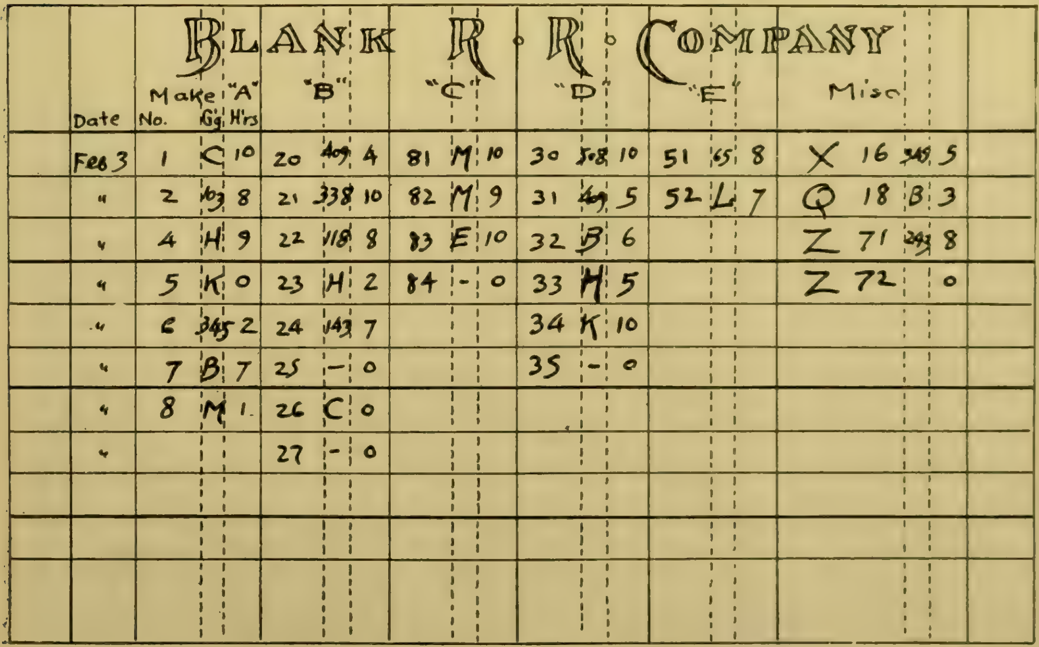


		BLANK R. R. COMPANY																		
	Date	Make "A" No.	S'z	Hrs	Make "B"			Make "C"			Make "D"			Make "E"			Misc. Makes			
	Feb 3	8	2	3							32,34	1	5							
	Feb 4				20,23	4	8				31	1	½	51		1½				
	Feb 5										34	1	2				X 16		1	
	Feb 6				26	5	6													

FORM FOR RECORDING HOURS OF LABOR, INSPECTION, CLEANING, AND REPAIR SPENT UPON EACH MOTOR.

spection, because they feared that they might miss getting the same machine Monday morning. Men who would not use a motor previously now began proposing its application to all kinds of jobs, and results in most cases justified complying with these suggestions.

Hitherto undesirable jobs of reaming, and drilling in contracted



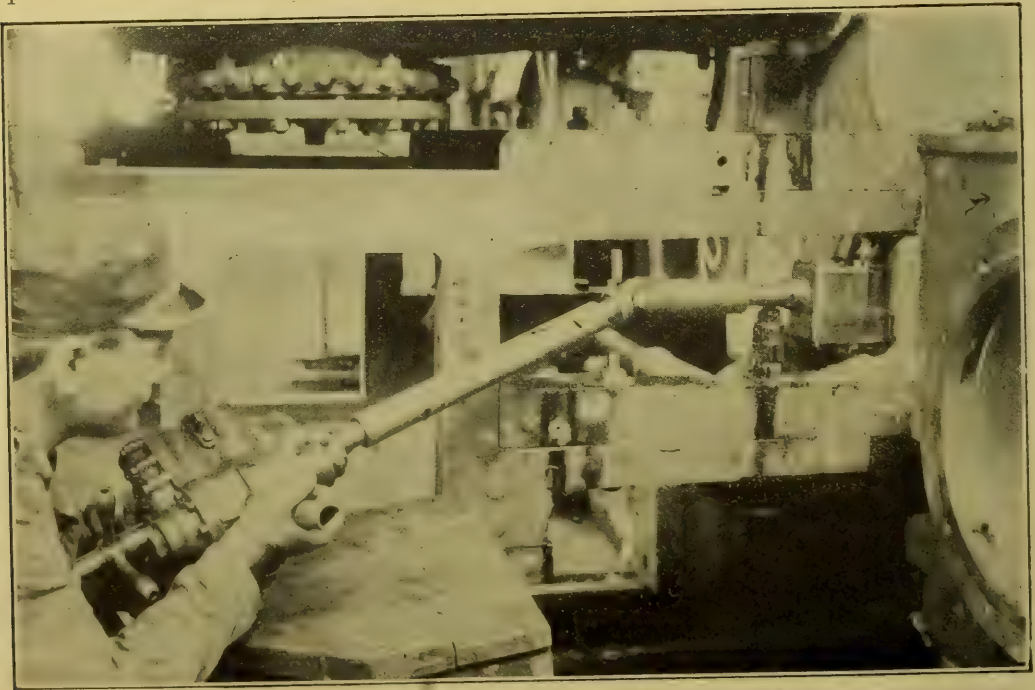
		BLANK R. R. COMPANY																		
	Date	Make "A" No.	G'g	H'rs	"B"			"C"			"D"			"E"			Misc			
	Feb 3	1	C	10	20	409	4	81	M	10	30	508	10	51	65	8	X 16	349	5	
	"	2	103	8	21	338	10	82	M	9	31	409	5	52	L	7	Q 18	B	3	
	"	4	H	9	22	118	8	83	E	10	32	B	6				Z 71	243	8	
	"	5	K	0	23	H	2	84	-	0	33	H	5				Z 72		0	
	"	6	345	2	24	143	7				34	K	10							
	"	7	B	7	25	-	0				35	-	0							
	"	8	M	1	26	C	0													
	"				27	-	0													

FORM FOR RECORDING HOURS OF SERVICE OF EACH MOTOR.

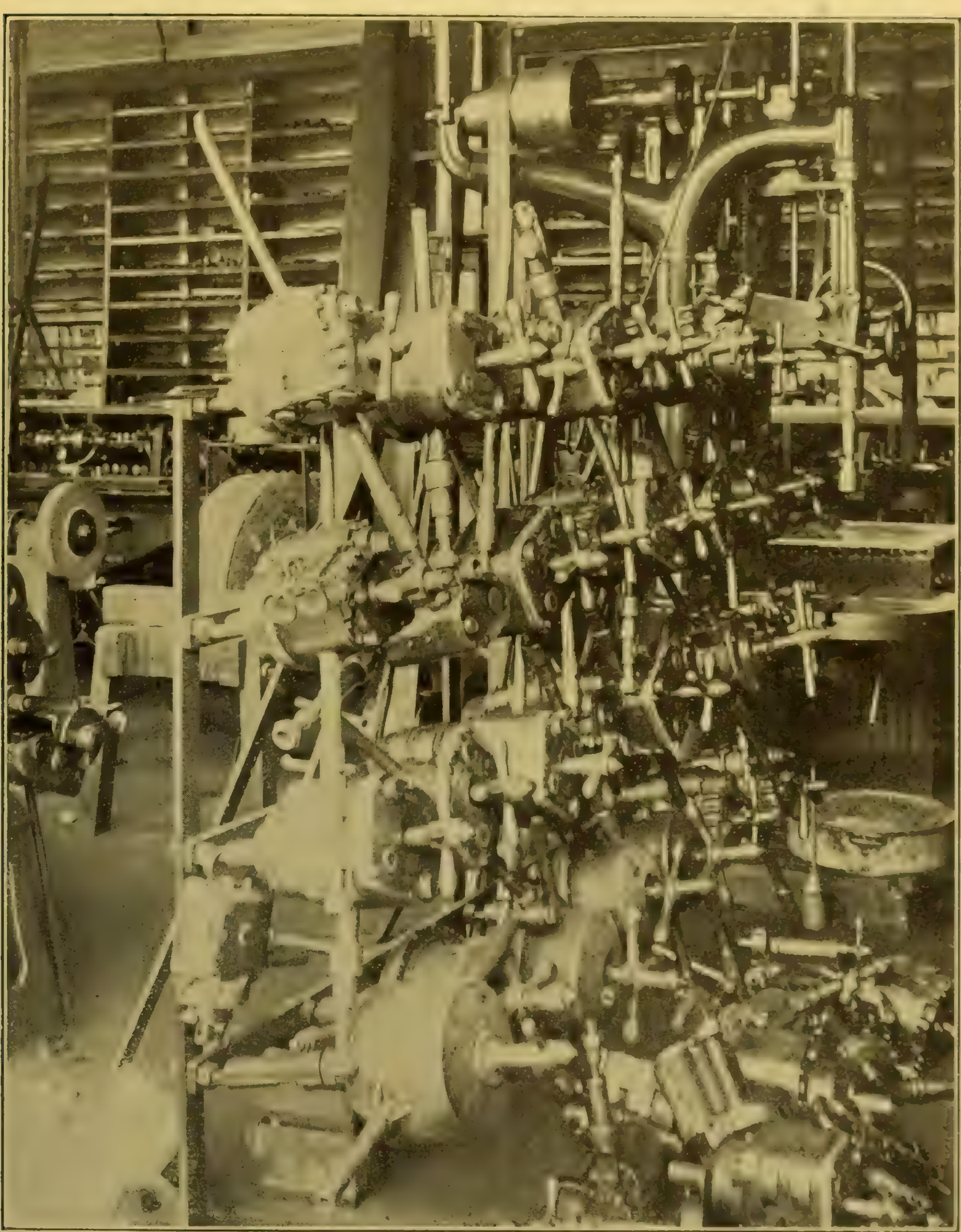
"G'g" means gang (or man) using each machine. All the forms shown are 8 by 5 inches, the horizontal lines being spaced 1/3 inch apart; ruled in light blue except the dotted lines, which are red; printed in brown.

GETTING MOTORS FROM THE TOOL ROOM.

spaces, were made so much easier that they were no longer shunned. The one item of reaming holes alone was cut to less than one quarter the former labor cost, when a heavier type of machine was



AN "UNDESIRABLE" JOB, MADE EASY BY USE OF ANGLE DEVICES IN CONNECTION WITH AN AIR MOTOR.



CONVENIENT RACK FOR STORING AIR MOTORS.

Designed by a tool-room machinist.

used. This was due to the fact that the mechanic did not need a helper and could work more quickly and to better advantage.

It will be noted that a number of repair items in the sample record illustrated are quite heavy; and it should be explained that these machines were the total of those "out-of-business" among over one-hundred in use in the shops, and that as there was a system of pay in effect rewarding men according to their individual effort, it was considered greater economy to wear out the machine by continual and heavy service, than to save the machine at the expense of shop output costs.

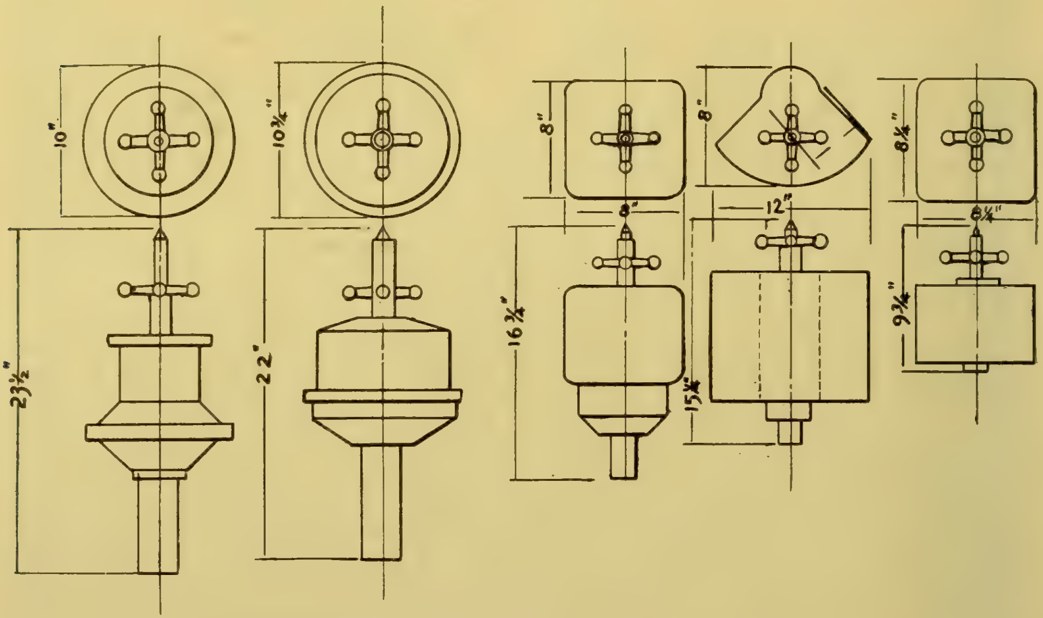


DIAGRAM OF COMPARATIVE SIZES OF MOTORS.

Comparative Motor Performance.—There is subjoined an outline drawing showing the general dimensions and sizes of the five principal motors put on the market in the past ten years. These motors have all received extensive use and are the best representatives of the most successful, mechanically and commercially, of the motors of the period mentioned. They are arranged, with one exception, in the order of their appearance on the market and the progress in lightness and compactness is very evident.

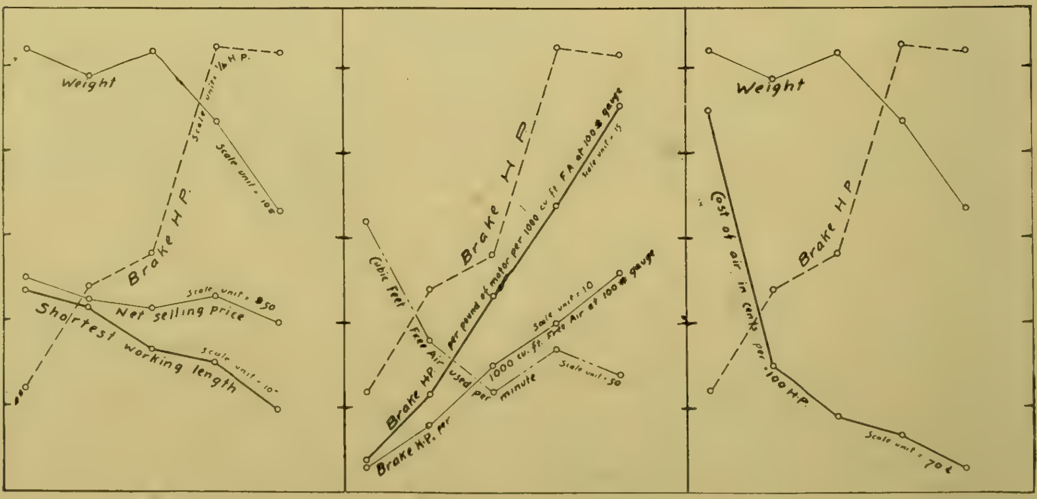
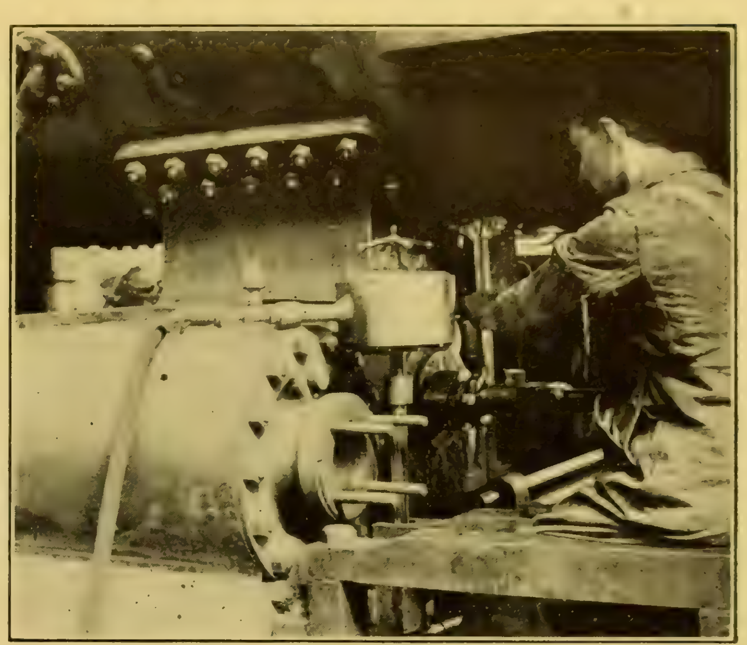
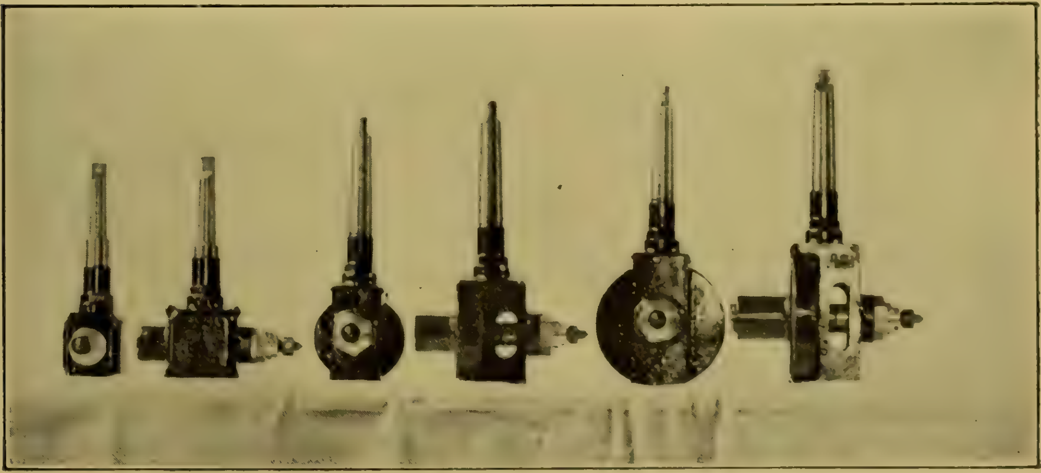


DIAGRAM OF DATA BROUGHT OUT BY TESTS OF AIR MOTORS.
Mean results of three-weeks test upon eight machines, using the method shown in the diagram above.

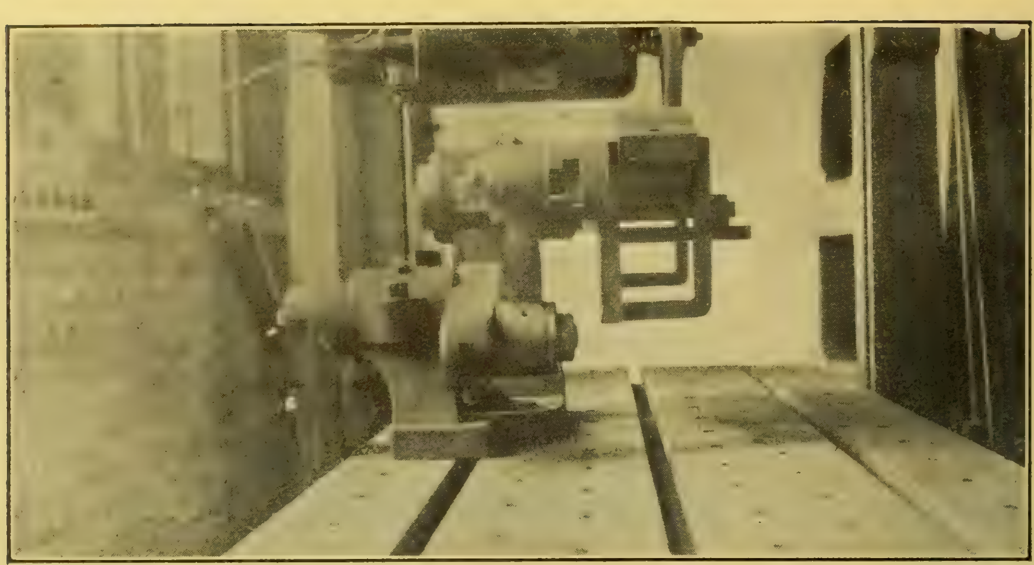


A FORMERLY "UNDESIRABLE" JOB OF REAMING, NOW DONE COMFORTABLY BY AIR TOOLS.

Some of the data obtained in the motor test are worthy of attention. The cost of compressed air was determined by a thorough one-week's test of the power plant. In the diagrams the small circles represent the five motors in the order in which they appear in the outline drawing. It will be seen that the net purchase price (in quantity) of these tools has slightly decreased, yet the design has been improved. The efficiency of the motor has increased in every way, also, in a surprising degree—the losses in the older types being due to large leverages and consequent working loose and wearing of parts, and to poor piston fits. It should here be stated, however, that in this series of tests the machines selected were all in good condition, the new ones having been "warmed up" by a few weeks of "active service" and the older machines having been previously put in thorough repair and adjustment, so that each machine might give the best performance of which it was capable.



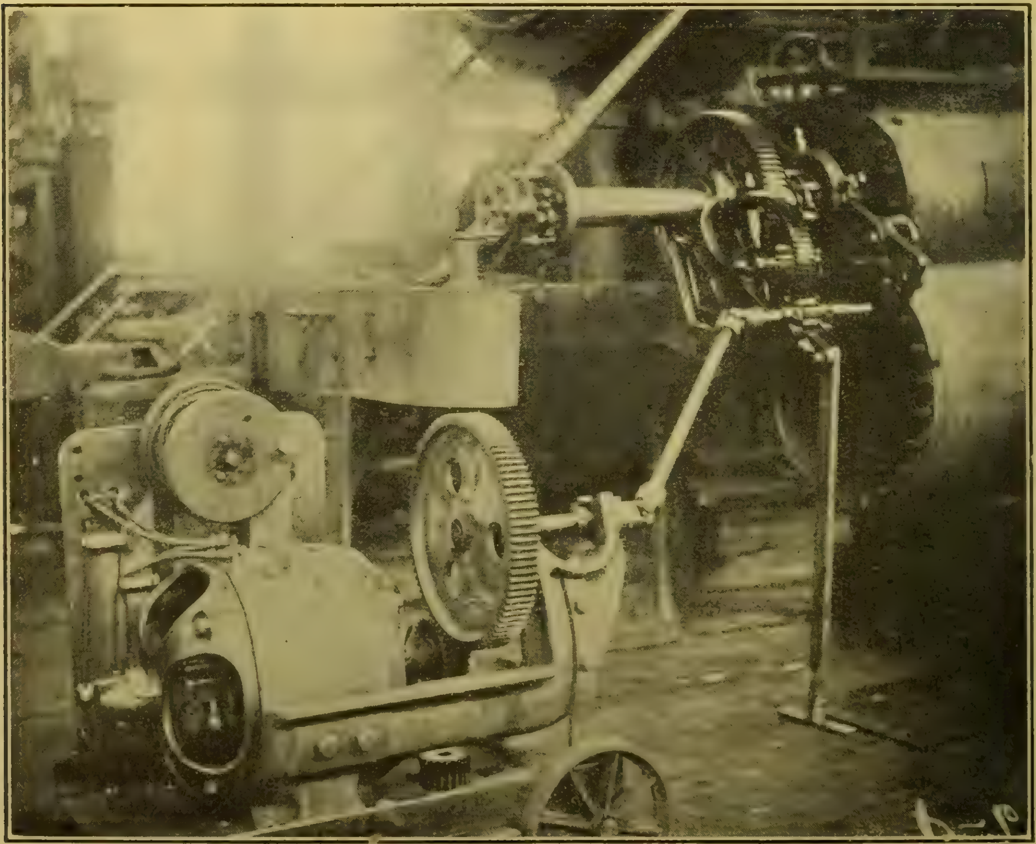
A GROUP OF ANGLE DEVICES FOR USE WITH AIR MOTORS.



PORTABLE ELECTRIC MOTOR CLAMPED TO A PLANER FRAME, ENGAGED IN GRINDING LINKS FOR LOCOMOTIVE.

Referring to the last of the three diagrams, the line representing relative costs of operation per unit of work is most striking.

The earlier casings and parts were heavy and large, to withstand as yet undetermined strains. Little attention was paid to the selection



A TRANSPORTABLE ELECTRIC MOTOR.

or testing of the materials used in the motor. The tool was driven at a point far away from the crank, and as no provision was made for balancing, the vibration was excessive. The oiling also was unsatisfactory. In the old "wing"-type motors it was difficult to keep the mechanism properly oiled, as the air driving the motor carried out the oil in the exhaust. In the later types, the cranks run in oil, and the air comes in contact with the piston only.

Simplicity of design, compactness, fewness of parts, are the elements that characterize the later types of motor. The strongest motor is not the heaviest; the most powerful is not the largest.

In examining into the reasons for the increased economy and compactness of the later types in proportion to power developed, it may be stated that a higher number of revolutions of tool-socket per minute has been one of the factors. In one of the later types, a two-speed gear provides for both slow and fast operations and this has been found of great use.

An important point is that in the earlier types, the repair and maintenance costs, as well as the operative costs, were excessively high, and that owing to this condition, the time lost by the machine to productive service was very great. Even under these disadvantages the early machines were able to compete economically with hand labor; and now it is a very favorable sign that the tendency is toward:

Decrease of weight, decrease of first cost, decrease of maintenance cost, decrease of operative cost, increase of efficiency and economy, increase in applicability to various classes of work, increase of time in service.

While it has been shown that the air motor has well earned an important place in modern industry, and is likely to extend its usefulness, it cannot of course be claimed that the field of power-driven portable tools will be held exclusively by pneumatic tools. There are certain classes and conditions of work for which they are peculiarly adapted, and in general practice, for reasons already mentioned, they will hold their own for long to come over electric and other rivals.

Portable Electric Motor.—In the past the electric motor has been handicapped in its introduction as a portable tool because of its great weight and comparatively high first cost, proportionate to horsepower developed. For this reason the air motor has held a virtual monopoly of this class of work, even in this "Age of Electricity." Owing to great improvements in design in the past two years, such as air-cooling of coils, etc., the electric portable motor is coming in for serious attention for practical shop-production improvement. An even further reduction of some 10 per cent in weight is possible by the use of aluminum in armature and field coils.

The illustrations show one type of portable electric motor, attached to a planer, grinding links which are given the proper motion by a jig on the bed of the planer. The common cord and Edison plug are used to make connections, with great convenience. While these motors are quite light, there is prospect of their being made still more so in future.

Although these motors are too new upon the market to venture any data as to their permanent efficiency compared with air tools of the same capacity, it may be said that they will find a very ready use in shops not at present equipped with an air-compressor, where electric energy is available. Automobile plants, buying their current, will especially find their use economical.

Considerations Governing Purchaser.—Not always having the advantage of special knowledge, or of experience, and lacking time and facilities for testing out before purchase, works managers and superintendents may be in doubt as to the paying value or comparative worth of all the machines and devices drawn to their attention by enterprising supply companies. To such men on the look-out for improved methods, and indeed to all intending purchasers of air-tool equipment, three main considerations are presented:

The tool should be of general adaptability. This is most important, and should largely govern the selection.

It should be maintained and operated at low cost.

Its first cost should not be prohibitive.

As is usually the case, the simplest and most compact motor, of light weight, of few parts, is at once most adaptable, easiest to maintain, and cheapest to make. Fewness of parts calls for less material, and less labor per piece. Assembly costs are less, as cheaper labor may be employed. What is here said of manufacturing costs applies equally to repair expense; with fewer parts there is less liability for wear, for lost motion, for breakage; there are fewer "extra" pieces to carry in stock, and there is increased time service.

No one cares to invest in a high-priced tool whose use is limited to a small class of work. I have seen contract shops loaded down with useless and expensive machinery, much of it standing idle the greater part of the time. In many modern railroad shops, the machine equipment is ill chosen, this being the main cause of the high repair costs prevalent in the last few years. If, however, one can be assured that the tool to be purchased, whether a heavy machine tool or a portable one, will be in constant service, the investment is well worth while.

EDITORIAL COMMENT

THE "thick weather" which for some time has been settling about the Panama Canal has apparently reached such conditions that only a lively squall, with much thunder and lightning, can effectually clear the atmosphere. That squall is now on in the Senate; and it may after all be welcomed, because when it has spent itself the situation will be revealed so clearly that a safe course can be made for the future.

The truth of the case doubtless lies between the impossibly perfect picture drawn by the Administration and the yet more impossibly hideous one painted by sensational attackers in both the daily newspapers and the periodical press. And it must be borne in mind that if critics of the work have based charges more or less personal upon information which was wrong, or wholly insufficient, the precedent was set by those high in authority in the conduct of the Canal construction. The correspondent who makes violent accusations against Mr. Taft or Mr. Shonts, on mere hearsay, is more excusable than Mr. Taft and Mr. Shonts are, for example, when they insinuate publicly that Mr. Wallace dumped the Culebra spoil where it would have to be moved again in the further work, and then add hastily that this insinuation is based upon rumor which they have not verified. The high official position which gave them every facility—indeed, imposed upon them the duty—to know the facts, doubled their grave responsibility in attacking an honorable professional reputation.

The course of events since our editorial reference last month, in which we pointed out the eminent desirability of letting the whole work by contract, has proved that position as no mere argument could ever have done. We are glad, indeed, to see that within the past few days Mr. Shonts and Mr. Stevens have expressed similar opinions. The whole country is in a turmoil over a job which, at the utmost, represents not more than half the volume of the engineering work now under way in and about the city of New York—proceeding, under the contract system, without confusion and almost without public notice. The greater part of the machinery of the Federal Government is diverted from its proper functions to the carrying on of the Canal investigation, and the whole executive management of the Canal is distracted from constructive effort to the business of being investigated. And so long as we persist in our present policy these conditions will be prolonged and repeated.

The methods and the machinery of Government bureaus and political offices may serve excellently for the transaction of official routine; they are hopelessly inefficient when turned upon constructive enterprise — especially upon any large engineering undertaking. Witness the public buildings all over the United States, and the glaring examples under the river and harbor bills. The nature and necessities of the two spheres are wholly dissimilar; it is no disparagement to either that it cannot properly perform the functions of the other. The only folly is to persist upon trying. The engineering staff of (say) the Pennsylvania Railroad, even by and with the assistance of two of the great engineering societies, would probably find themselves ill adapted to conduct the affairs of the

Department of State, and would frankly admit their inefficiency on the job; but they would not be farther from their ideals than the War Department is in trying to manage the building of the Panama Canal. Indeed, of the two the engineers might come best out of the situation.

We do not hold for a moment that this implies any lack of personal capacity or of the most earnest purpose on the part of the President or the Secretary. They are doubtless doing all that any men could to carry out the difficult commission placed upon them by the country. But what of the very possible change of personnel in the highest offices which may occur before the Canal is finished? What if the energy and knowledge of President Roosevelt and Mr. Taft should be displaced by a vacillation, an unfamiliarity with or even an unfriendliness to the work, in the persons of their successors? Further, the Canal will always appear to enemies of the Administration to be a most vulnerable point—a sort of football of politics; and with each new Congress there will be new attempts—possibly with the very best motive behind them—to reopen the most fundamental questions in the whole concept.

A great physical problem dealing with the facts and forces of Nature cannot be practically solved under such conditions. In the interest of the President and his Cabinet, as well as in the National interest, the charge given the Administration should be so modified (if, indeed, modification of its form is necessary) that it demands from them nothing except that which is within the sphere of their proper office.

In other words, to cite recent concrete examples, the work should be done as in the case of the New York Subway or the Chicago Drainage Canal—upon plans determined by a competent commission, under the constant and effective supervision of their engineers, but by an organization, a mechanical equipment, and working methods supplied by the contractors. This is, indeed, the method by which the greatest engineering works of the world, and all over the world, have been completed—with the maximum of efficiency, the minimum of cost, and the absence of scandal.

It implies no surrender of control of any essential feature either of plan or policy. Any and every provision which National ideals or public expediency may suggest can be embodied in the specifications. The public eye, as well as the official eye, can be and would be over the work night and day. And it would be easier even than now to secure, for the oversight and control, men who are above reproach, personal or professional.

We hope that the present inquiry may carry the light into the farthest corners of the Isthmus and of the departments at Washington—that every one who has evidence to give or a grievance to allege may appear and be heard to his heart's content. This is the time for it. But as sincere and consistent advocates of the best canal, for the least cost, and in the shortest time possible, we most earnestly hope that the era of talk may then give place to the era of work. And, in our conviction, this involves two steps:—

First, prompt decision upon the plans and specifications.

Second, commitment of the construction, upon well-established and elsewhere universally successful lines, and after open competition, to competent, responsible, and amply bonded contractors or contracting organizations.

The policy which built successfully the great railroads of the United States and the vast majority of all the important engineering projects conceived and carried out by our shrewdest financiers and ablest business managers, without friction or disturbance of municipal, State, or National affairs, is the only sane and safe policy for the building of the Panama Canal.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE RESISTANCE OF MATERIALS TO SHEAR.

EXPERIMENTAL TESTS TO DETERMINE THE ACTUAL BEHAVIOUR OF MATERIALS OF CONSTRUCTION UNDER SHEARING STRESSES.

E. G. Izod—Institution of Mechanical Engineers.

AMONG the various conditions of stress to which materials of engineering are subjected in construction and operation that of shearing action has been given a smaller share of attention than its importance warrants. By far the greater number of tests of materials are made by subjecting the specimen to tension, while compression tests, torsion tests, drop tests, and other forms of trial have been largely employed. In many of the text books the resistance of a material to shear is based upon the resistance to tension, an arbitrary relation being given without due attention to the obvious fact that this relation must differ for materials of different kinds. The importance of the study of shearing action is manifest when it is considered that it exists in nearly every case in combination with other stresses, and in some instances it may become the element of controlling importance as regards the safety of the structure under consideration. Thus, in the case of a deflected beam, the upper portion may be under tension while the lower part is in compression, but manifestly the neutral plane, where tension ceases and compression begins, is under shear, the forces above and below acting in opposite directions. In like manner shear forms an important element among the stresses existing in cases of torsion, and it is well known that the recent re-investigation of the distribution of shearing stresses in masonry dams has attracted much attention and created some little apprehension in connection with such structures. In a paper recently presented before the Institution of Mechanical Engineers by Mr. E. G. Izod there is given the results of some actual tests made to determine the behaviour of materials under pure shear, and the results may be received as a welcome addition to a department of engineering in which the stock of information is none too complete.

The experiments of Mr. Izod were made in the engineering laboratory of University College, using a 100,000-pound Greenwood & Batley testing machine with special clamps arranged so as to eliminate, as far as practicable, any bending of the test piece, and to insure the production of a pure shearing action. The tests were made upon pieces of rectangular section, and tensile tests were also made upon corresponding pieces of the same materials, the intention being to discover what relation, if any, existed between the resistances to shearing and to tensile stress. The tests included such materials as cast iron, wrought iron, steel, and a variety of bronzes and brasses, the steels including mild steel plate and Swedish crucible steels with carbon content from 0.12 to 0.77 per cent., the results being tabulated and plotted in curves.

For the details of the tests the reader must be referred to the original paper, but some of the interesting points brought out in the paper and in the discussion may be noted here. Apparently no positive relation exists between the shearing resistance and the tensile strength of a material.

"All the results obtained in the experiments seem to point to the fact that there is no common law connecting the ultimate shearing stress with the ultimate tensile stress, the ratio varying greatly with different materials. The test figures from the crystalline materials, such as cast iron or those with very little or no elongation, seem to indicate that the ultimate shear stress exceeds the ultimate tensile stress by as much as 20 or 25 per cent., while from the fibrous materials, or, more properly speaking, those with a fairly high measure of ductility, the ultimate shear stress may be anything from 0 to 50 per cent. less than the ultimate tensile stress."

Thus, for wrought iron, the shearing strength appears to be about 75 per cent. of the tensile resistance, while for cast iron the resistance to shear runs from 10 to 52 per cent. above the tensile strength. The low-carbon steels show about the same ratio as wrought iron, while a crucible steel of 0.71 carbon has a shearing strength of 65 per cent. of the tensile.

In comparing the ratio of shearing to tensile resistance with the elongation, a certain relation appears, there being a certain uniformity in the results. Thus, when the ratio of the shearing to the tensile resistance is close to 60 per cent., the elongation shows very little variation from 10 per cent. Below and above the 60 per cent. ratio the elongation increases, that at the 50 per cent. ratio being almost equal to that at 70 per cent., while from the 70 per cent. ratio upwards the variation is inclined to be regular, the elongation decreasing as the ratio becomes higher, until with a very small, or practically no elongation the ratio might be expected to become 120 per cent. or 130 per cent.—that is, that the ultimate shear would exceed the ultimate tensile stress by 20 or 30 per cent.

In the course of the discussion on Mr. Izod's paper some interesting points were brought out. Thus, Professor Lilly called attention to the fact that tests for ultimate strength were destructive tests, so that the load is not uniformly applied over the entire section, and that different results are obtained with different depths of test piece. He also spoke of the fact that the shearing resistance bears a relation both to the tensile strength and the compressive strength of a material. In this respect it may be of interest to note the investigations of Professor Mörsch, in Switzerland, reviewed in the issue of this Magazine for March, 1905. Although the investigations of Professor Mörsch related more especially to concrete, they included the general question of the relation of shearing stresses to tension and compression, and showed that in general, the resistance to shearing is found to be a mean proportional between the tensile and the compressive strength, so that the resistance to shearing may be taken as the square root of the product of the tensile and compressive resistances. Since Mr. Izod does not give the compressive resistances of his test pieces it is not possible to apply this rule to his experiments, but it can well be seen that for materials with a proportionately high resistance to compression, such as cast iron, this would give a shearing resistance materially higher than the tensile strength, while for a material in which the compressive resistance is lower than the resistance to tension the ratio would be lowered. An examination of the appearance of the ruptured sections of specimens divided by shearing will show that both the tensile and the compressive resistances of the material have been overcome, and hence it is but reasonable to expect that the shearing resistance should be a function of them both.

There is little doubt that resistance to shearing plays an important part in nearly every form of resistance to stress, and this is indicated by the fact that when rupture occurs it nearly always takes place in some other direction than that normal to the applied stress. Thus, in the case of yielding to tension, the test piece very rarely yields by breaking straight across, the break being in a diagonal direction, or with a conical fracture. When tubes are ruptured by internal pressure the break is a diagonal one, unless, by reason of a weld, seam, or other change in homogeneity the line of the break is otherwise localized. In every case there are undoubtedly a number of causes and effects operating together, and it is a distinct error to assume that one particular cause can be selected as producing an especial effect.

Such experiments as those of Mr. Izod are to be welcomed, but it is greatly to be desired that any such piece of work should be undertaken with an entirely open mind, not with the preconceived intention of finding out the relation, as in this case, between the tensile and the shearing resistance, but in a spirit of unbiased investigation of all the associated phenomena, so that the true relations of all the elements involved may be determined. If, in connection with these valuable tests, there had been associated a simultaneous set of tests of the tensile, compressive, torsional, and bending resistances, together with the chemical and physical properties of the various specimens, and the resulting mass of data had been critically examined to discover the nature of their relations, there is little doubt that a different set of conclusions would have been reached. Independent investigations are not to be discouraged in any case, but it requires only an examination of such painstaking work as that performed by Mr. Izod to render it evident that it is only by a concerted attack upon the action of molecular forces that the true nature of their action can be discovered.

MODERN FOUNDRY PRACTICE.

TENDENCIES TOWARD COMMERCIAL AND TECHNICAL REFINEMENTS IN THE CONDUCT OF FOUNDRY OPERATIONS IN THE UNITED STATES.

Dr. Richard Moldenke—New England Foundrymen's Association.

IT has often been remarked that the foundry is the one department of the machine works which has lagged behind in the march of improvement, and a few years ago such a statement might have been made with a fair approach to accuracy. The rapid progress in all departments of industry of late has extended to the foundry, however, and to-day, in first-class establishments the latest developments of chemistry, metallurgy, and mechanism are applied to improve the quality and reduce the cost of the product. In a paper recently presented before the New England Foundrymen's Association by Dr. Richard Moldenke, this tendency toward the introduction of refinements in foundry practice is discussed, with especial reference to foundry work in the United States, and we make some abstract and review of this discussion of an important department of engineering work.

"Perhaps the very first thing which strikes the European foundryman who is visiting American plants is the great stress laid upon system and organization in our strictly modern establishments. The European founder, with his more varied work of smaller aggregate tonnage, casts his pieces one by one and finishes each with the assembling following directly. We, with an eye to the finer economies, prefer to put through an order of anywhere from a dozen to thousands of pieces of a kind, finishing them up for sock and stealing the parts required for sales and promises. As the stock in the warehouse gets below a certain minimum another shop order goes in to fill up the gap. As a consequence the work is always produced at the cheapest rates possible. I have personally known single orders of 100,000 castings of some 30 pounds each given with simply a blue print of the casting attached to the document. Many times the quantity has been 30,000 to 60,000, which meant that economical work could be done here if anywhere. Actually the figures at which these castings were carried out would be astonishing.

"Apart from the use of moulding machines to turn out these classes of castings cheaply there is a noticeable tendency to economize shop room, and hence moulds are piled as high as they can be conveniently poured. It may be objected that this method oftentimes produces more sprues per pound of casting than the old way and that if trouble comes a stack of moulds will be ruined instead of only a single one. Yet this system has been found to pay wherever tried and the getting of more tonnage for a given floor space is bound to spread. The idea, however, should be followed out to its logical end wherever work is made in sufficient quantity. This would seem to be the stacking up of the moulds in fairly deep foundry pits, the iron being brought in large ladles by traveling crane and poured from the bottom of the ladle. Suitable variations in the method can naturally be devised for given cases, but the idea remains the same —to get the greatest tonnage for a given floor space in order to save investment and cost of output.

So far as the question of the preparation of foundry sand is concerned, Dr. Moldenke affirms that European shops are far ahead of those in America. It is by no means difficult to determine the locality in which an American casting has been made, by reason of the different grades of moulding sand employed in different districts, the local sand being generally employed in the United States, whereas, in Europe, selected sands are ground to a given standard, and passed through mixers, giving a uniform material best adapted for the work to be done. The art of tempering sand is counted among the important qualifications of a skilled foundryman, but it is really an operation best performed by the aid of proper mechanical appliances. As a matter of fact, the introduction of mechanical appliances in the foundry is increasing in various departments, including mechanical charging for cupolas and furnaces, conveyors for moulds and for sand, cranes for the foundry and for the yard, and a variety of portable pneumatic tools and appliances. It is nearly always found profitable to replace manual labor by machinery and reserve human effort for operations requiring the possession of brains and the exercise of judgment. The foundry which is provided with the best modern equipment represents a larger investment, but it is better prepared to meet competition and escape labor difficulties.

"There is a growing demand for foundry standards. Thus flasks, pattern work and the moulding methods depending upon the close co-operation of the pattern shop with the moulding floor are coming in for considerable attention. The makers of moulding machines will be greately benefited by this desired standardization of flasks, for the time has now gone by when a manufacturer would go out of his way to get the most impossible screw thread in order that the repairs subsequently necessary would have to come to him. We shall undoubtedly see the day when all the designs of the drafting office of an industrial establishment will go for revision to its foundry superintendent in order to standardize the non-essential elements therein and create less labor in producing the castings.

"In going through many a foundry where very large loam moulds are made for stock work one cannot help regretting the tearing down of much of the mould which might be left standing if the subject of permanent moulds had been studied more carefully by the foundry foreman. The effort to-day is to economize in every way possible and very often here is a chance to begin.

"We owe much to our high class custom pattern shops for the progress they have forced upon the pattern end of our industry. It is not so long ago that metal patterns were unheard of in many foundries. It seemed like a waste of good money to put more time and effort on a pattern than was required by the ordinary article we all have piled on our pattern shelves. However, many a shop to-day can boast of a set of metal cutting machines which remind one of a first-class tool room. This tendency is, however, closely interwoven with the specialization of the foundry, and where a first-class man is in charge the pattern storage soon becomes less of a graveyard for obsolete material."

An interesting feature in connection with the development of the foundry business appears in the improved character of the buildings of recent construction. This is partly due to the increasing cost of wooden buildings, and also to the desire to avoid the delays and losses due to fire. The loss of patterns in many cases is much less than the loss due to delays in replacing them, and it is evident that good fire protection is better than any practicable insurance.

"Turning now to the melting and the closely allied laboratory we see that the most strongly marked feature is the production of higher grade castings by the addition of steel scrap—or, in other words, the reduction of the total carbon in cast iron, making the crystalline structure more closely adherent and hence the whole casting stronger. Here the skill of the melter is joined with that of the chemist so that value is received from the higher priced stock charged into the cupola. The cupola process is being studied more carefully and experts in that line can produce results close to those of the air furnace or open hearth. Considering that this is accomplished with fuel and metal in contact and by a notoriously unsatisfactory melting method, which the cupola process undoubtedly is from the standpoint of the treatment the metal gets in it, the foundry industry is to be congratulated upon its ability to retain a strong hold on the making of castings in the face of the hard knocks it is getting from the steel casting establishments. This movement toward better grades of metal is but in its infancy. The cupola, which is a cheap melter, will undoubtedly be improved with the view of getting better results from the steel scrap additions. The metal will be safeguarded more from burning and the additions of the scrap will be systematized more, so that a given quantity will produce given results more regularly than is now the case.

"The tendency above mentioned has somewhat retarded the introduction of air furnaces in general foundry practice. However, taking into consideration the demand for better irons, better coke, better melting methods, the specialist founder will soon tire of buying high class material and spoiling it or taking big chances in that direction. He will naturally revert to the air furnace as better able to give high class results from high class material and the consumer will be glad to pay the difference."

Referring to recent applications of metallurgical improvements in the foundry, Dr. Moldenke speaks of the use of ferro-alloys for correcting various troubles. Ferro-manganese and ferro-aluminum are both extensively used to remedy the defects caused by poor pig and poor coke, but these are only imperfect remedies. Dr. Moldenke believes that the real foundry alloy is yet to be discovered, and hopes that its advent will not be long delayed.

The possibilities of the electric furnace are also indicated and by using cheap fuel gas in gas engines for the economical production of the electric current it appears to be practicable for makers of small castings to use the electric furnace to melt ready prepared stock for steel or bronze castings to advantage. By the employment of preliminary heating processes the use of the expensive electric current may be reserved for the final melting operation, and along such lines there appears to be opportunity for some very practical developments.

SUPERHEATERS FOR STEAM TURBINES.

EXPERIMENTAL TESTS UPON THE ECONOMY EFFECTED BY THE USE OF REHEATERS AND REGENERATORS WITH STEAM TURBINES.

J. Nadrowski and O. Dahlke—Verein Deutscher Ingenieure.

IN the course of the various attempts which have been made to increase the thermal efficiency of the steam turbine, those involving the use of superheated steam have attracted much attention, the experiments of Professor Lewicki, in the laboratory of the technical high school at Dresden being especially noted.

There has recently been conducted at the Dresden high school a series of additional experiments upon the steam turbine, these being made by Messrs. Nadrowski and Dahlke, and involving the use of superheating of the steam before it entered the turbine, as well as the abstraction of all the available heat from the exhaust on its way to the condenser. The experiments also included tests upon compounding, and in these trials arrangements were made for reheating the steam in its passage from the high-pressure to the low-pressure turbine. In view of the general care with which these experiments were conducted and the broad interest at present existing in all that relates to the steam turbine, some abstract of this work is given, with data and results of the trials.

The testing plant at the Dresden laboratory includes a horizontal boiler, with large furnace-flue, the shell of the boiler being 2.30 metres in diameter, and the furnace-flue 1.30 metres inside diameter, with grate 1.20 metres long, and a combustion chamber of about equal length behind the bridge wall, beyond which a retarding wall serves to check the velocity of the gases and guide them through the remainder of the flue, this portion being about 4.50 metres long and 1.25 metres in internal diameter, and arranged to contain the superheating and reheating tubes. The gases, after passing through the internal flue, return beneath the shell of the boiler on their way to the chimney. As in a number of recent internal-flue boilers, the furnace-flue is not placed on the centre line of the shell, but to one side, this arrangement facilitating the circulation of the water, and in the case of the boiler at the Dresden laboratory there are a number of small tubes run through the water space alongside of the main flue, these tubes being so connected that the exhaust steam from the turbine can be passed through them. There is also a horizontal closed feed-water heater placed by the side of the boiler, this heater consisting of a shell for the water, with a number of straight tubes passing through it tor the exhaust steam.

The superheaters are arranged in the form of tubular spirals, placed in the main boiler flue, and hence surrounded by the hot gases passing from the combustion chamber. There is one main central spiral, intended to be used for superheating the live steam before it passes to the turbines, while around this are arranged seven smaller spirals, through which the exhaust from the high-pressure turbine can be passed for reheating the steam before it enters the low-pressure turbine. Both superheaters can be connected in parallel, when extremely high primary superheating is desired.

The turbines themselves are of the De Laval type, one being of 50 and one of 100 horse power, arranged to be coupled together and directly connected to a double Siemens & Halske dynamo, so that the power can be absorbed and measured electrically. The whole arrangement is excellently adapted for experimental research, and from the care with which the installation has been planned the results should be reliable.

In the conduct of the tests the steam consumption was determined by weighing of the feed water, the power required for the feed pump being determined separately, and deducted from the result. The only element which was not properly proportioned to the service was that of the condensation, since the air and circulating pumps formed a part of an independent condensing plant designed for a much larger quantity of steam, and hence was not operated at the best efficiency, a matter which should be taken into account in considering the results. Moderate temperatures were taken with mercury thermometers, while temperatures above 100° C. were measured by means of a thermo-couple, all instruments having been standardized at the Reichsanstalt.

At the commencement of the trials the turbines were operated at very high temperatures, in order to demonstrate what had already been maintained by Professor Lewicki, that there is no difficulty in running turbines of the De Laval type at high temperatures without injury to the bearings, nozzles, or blades. Thus the machines subsequently used in these tests were operated with steam superheated to a temperature of 530° C., without injury, and temperatures of 400° C. were readily maintained continuously without producing any injurious effect either upon the superheaters or machines.

Experiments upon the use of highly superheated steam in turbines have shown that it is possible to use to advantage steam temperatures which leave the exhaust steam to be discharged at a higher temperature than that of the boiler. Under such conditions it is evident that a gain will result if this exhaust steam is passed through the boiler and permitted to return its excess heat. The steam, then being at boiler temperature, may still be used to give the feed water a preliminary heating, before entering the condenser. It is evident that the exhaust steam from a turbine, if itself still somewhat superheated, is well adapted for use in a low-pressure turbine, and when a steam reheater between the two turbines is used, there may yet be sufficient heat left in the final exhaust to be worth returning to the boiler, before passing to the feed-water heater. Such is the line of experiments conducted at the Dresden laboratory, and from the paper above referred to, in which the details of the arrangement are fully described, and the logs of the tests given, the final results are taken.

In the first series of tests a turbine was operated non-compound both at low and high pressure, with superheating to 400° C., using the regenerator to abstract the excess heat from the exhaust. Under these conditions, with a steam pressure of 1.4 atmosphere absolute, and a condenser pressure of 0.1 atmosphere (initial pressure about 5 pounds per square inch, and vacuum 27 inches of mercury) the result was a steam consumption of 8.22 kilogrammes per horse power per hour, or 18.1 pounds. With an initial pressure of 7 atmospheres, or about 100 pounds, the vacuum remaining the same, the steam consumption fell to 6.58 kilogrammes, or 14.5 pounds, per horse power, the steam being superheated to 400° C. as before; these corresponding to thermal efficiencies of 8.7 and 10.6 per cent. respectively.

With the compound arrangement the initial pressure was raised to 13 atmospheres, or 185 pounds; the pressure of admission to the low-pressure turbine being 1.2 atmosphere, or about 3 pounds per square inch, the vacuum being kept at 27 inches. Trials were made under these conditions, with steam superheated to 300° C. and to 400° C., the result being, in the first case a steam consumption of 5.89 kilogrammes, or 12.96 pounds; and in the second case 5.07 kilogrammes, or 11.15 pounds per horse power per hour; these corresponding to thermal efficiencies of 11.5 and 13 per cent. With an initial pressure of 16 atmospheres, and a temperature of 300° C. before the high-pressure turbine, and 500° C. reheating before the low-pressure turbine, and a vacuum of 28.5 inches, it is believed that a thermal efficiency of 18 per cent. may be attained, practically equal to that of the average gas engine.

INDUSTRIAL ENGINEERING MANAGEMENT.

THE ENTRANCE OF THE ENGINEER INTO THE COMMERCIAL AND INDUSTRIAL DEPARTMENTS OF PRODUCTION.

Hugo Diemer—Indiana Engineering Society.

DURING the past fifteen or twenty years there has occurred a veritable transformation in the matter of the industrial management of manufacturing establishments. Formerly the dividing line between the engineer and the business manager was drawn hard and fast and neither thought of attempting to overstep the limit. To-day it is realized that unless a proper combination is made of commercial and engineering methods the prospect for success is an industrial undertaking is exceedingly remote. In a paper presented before the Indiana Engineering Society by Mr. Hugo Diemer this subject of industrial engineering is discussed in an interesting manner and some comments upon his discussion of this important subject are here given.

After referring to the early discussions of the matter, including the reluctance of both engineers and business men to admit the work of each other to their respective domains, Mr. Diemer calls attention to the fact that the recently elected President of the American Society of Mechanical Engineers, Mr. F. W. Taylor, was one of the earliest advocates of modern industrial engineering, and that he stands to-day among its foremost representatives, this indicating more clearly than any discussion the present attitude of the engineering profession towards the subject of modern works management.

"As early as 1889 Mr. Taylor earnestly pleaded that shop statistics and cost data should be more than mere records and that they in themselves constituted but a small portion of the field of investigation to be covered by the industrial engineer. While he did not so express himself the gist of his treatment of factory management is this: He considers a manufacturing establishment just as one would an intricate machine. He analyzes each process into its ultimate, simple elements and compares each of these simplest steps or processes with an ideal or perfect condition. He then makes all due allowances for rational and practical conditions and establishes an attainable commercial standard for every step. The next process is that of attaining continuously this standard involving both quality and quantity and the interlocking or assembling of all of these prime elements into a well arranged, well built, smooth running machine. It is quite evident that work of this character involves technical knowledge and ability in science and pure engineering, which do not enter into the field of the accountant. Yet the industrial engineer must have the accountant's keen perception of money value. His work will not be good engineering unless he uses good business judgment. He must be able to select those mechanical devices and perfect such organization as will best suit present needs and secure prompt returns in profit. He must have sufficiently good business sense to appreciate the ratio between investment and income. He must be in close enough touch with the financial management to be able to impress upon them the necessity of providing sinking funds to provide for the more perfect installations and organizations which future demands of a more educated and enlightened public will necessitate."

There are few business men to-day who would seriously consider entering upon any important undertaking without competent legal advice, and the old saying about the status of the man who undertakes to be his own lawyer is well known and often quoted. The consulting engineer to-day occupies a similar position in many instances to the legal adviser. This has long been the case with the mining engineer, and upon his examinations and reports great investments and undertakings are continually being made. The industrial engineer does more than this, he not only reports upon the present value or lack of value of a manufacturing enterprise, but he shows how a wasteful management may be converted into an economical one, or how apparently disastrous competition may be successfully met.

"The word production indicates the making or manufacturing of commodities. Engineering as applied to production means the planning in advance, of production so as to secure certain results. A man may be a good mechanic but no engineer. The distinction between the mechanic and the engineer is that the mechanic cuts and tries, and works by formulæ based on empiricism. The engineer calculates and plans with absolute certainty of the accomplishment of the final results in accordance with his plans, which are based ultimately on fundamental truths of natural science.

"It is the business of the production engineer to know every single item that constitutes his finished product and every step involved in the handling of every piece. He must know what is the most advantageous manufacturing quantity of every single item so as to secure uniformity of flow as well as economy of manufacture. He must know how long each step ought to take under the best attainable working conditions. He must be able to tell at any time the exact condition as regards quantity and state of finishedness of every part involved in the manufacturing process.

"The engineer must be able not only to design, but to execute. A draftsman may be able to design, but unless he is able to execute his designs to successful operation, he cannot be classed as an engineer. The production engineer must be able to execute his work as he has planned it. This requires two qualifications. He must know men and he must have creative ability in applying good statistical, accounting and system methods to any particular production work he may undertake.

This question of the management of men is a vital one, and one which includes not only a familiarity with economic and sociological subjects, but also that familiarity which comes of actual experience and contact with mechanics in all departments of their work.

"A manufacturing organization being a live, human thing, is like a municipality. Many of our shops are as fruitful fields for riddance of graft as are many of our cities. The graft in the shop consists mostly in the distortion of the managing and planning body into a wire-pulling and influence machine with easy berths filled by incompetents or idlers. This condition often exists not because of any intentional desire to be disloyal on the part of the employees, but simply on account of the work being allowed to drift without systematic attention to departmental organization."

It must be clearly understood that the best system and the most ingenious mechanical appliances will not make men honest, and that one can no more create integrity by machinery than by legal enactment. Cases are well known in which grafting foremen have deliberately utilized mechanical recording devices to make deceptive records, using their authority and opportunity to divert a good system to their own dishonest ends. In this respect works management does not differ from any other department of business, and similar conditions obtain in both cases.

"The owners of an industrial establishment can do no wiser thing than to sit down and prepare a graphical chart showing their organization by departments and in detail as it really exists and then prepare or have prepared for them another graphical chart, showing that organization from a wholly impersonal standpoint, which would be the most effective for plant efficiency. When manufacturers once get so far as to prepare and compare such charts and see the opportunities for improvement, they will not hesitate long to take advantage of them. It would be the height of folly to say that such improvement is possible in every manufacturing establishment, since herein lies the secret of greater effectiveness and higher profits of many an establishment over its competitors in the same line of business. This very fact, however, should be the best reason for manufacturers to prepare such charts, which act as mirrors in giving them a true picture of themselves."

Mr. Diemer discusses at length the educational side of industrial management, showing the extent to which the question is already treated in the technical schools and colleges, and indicating the lines along which, in his judgment, further improvements may be made. Concluding, he calls attention to the important fact that the whole matter should be based upon the position of practical economy and money-making, and not upon that of philanthropy or advertising.

"The owners of progressive industrial corporations are beginning to realize that the financial returns from good organization, good production methods, good successful merit wage systems and the development of human efficiency are so great that they can afford to pay better salaries than have been the rule in the past to department heads and foremen provided they are properly trained by education and experience to accomplish results. The more progressive shop owners are beginning to realize that the question is one of engineering. The expert accountant, the system man, the salesman for system appliances, are but partially equipped by education or experience to undertake the work of production engineering. The qualifications required include all of the good ones which these men have. In addition to possessing these qualifications a competent expert in industrial management and production engineering must be a thorough mechanical engineer, technically educated, broad minded, with creative and executive ability, with the system man's knowledge of accounting and statistical methods and with wide experience in economic and labor questions. There will be an increasing demand for men with these qualifications and there is no danger that there will be an over supply."

PROGRESS IN SPACE TELEGRAPHY.

A REVIEW OF RECENT ADVANCES IN THE TRANSMISSION OF COMMUNICATIONS THROUGH SPACE BY ELECTRIC WAVES.

J. Erskine Murray—Institution of Electrical Engineers.

ALTHOUGH there have been few announcements of a startling nature of late concerning the development in the electric transmission of messages through space, the subject has been making steady progress, and at the present time wireless messages form a regular portion of the communication service of the community. In a paper presented before the Glasgow section of the Institution of Electrical Engineers by Dr. J. Erskine Murray, a review is given of recent advances in space telegraphy, together with some discussion as to the theory according to which the phenomena may be explained.

By far the greater number of installations at present in operation are used in connection with passenger steamships for communicating with the shore and with each other, and for this purpose the untuned coherer system of Marconi is principally employed, sometimes with minor variations and under other names. Untuned systems are being displaced by tuned systems, but the comparative simplicity and ease of working of the former have led to its extended use for distances under 150 miles. Dr. Murray explains that the reasons for the limitation of the Marconi untuned system to distances of about 150 miles is due to the fact that at such distances the lines of force from the charge on the aerial wire have time to reach the receiving station before the spark occurs at the transmitter.

Under such conditions it is only necessary to have an electrostatic charge suddenly discharged, either with or without oscillations.

The action under such circumstances is described by Dr. Murray as follows: "The aerial wire is charged, say positively, and lines of electric force spread out from it, having their negative ends on the earth surface all round, some of them ending on the aerial wire of the distant receiver. When the electrical pressure has become so great that the spark jumps across the gap between the aerial and the earth wire there is a sudden change in the distribution of electricity. The negative spread out over the earth or sea and on the aerial of the receiver rushes in toward the positive, producing a current of quite appreciable voltage, though of very short duration, and it is this current which actuates the receiver in passing through it from the aerial wire to the earth."

Under such conditions it is evident that any receiver within range will be affected, and there is no practicable way of preventing interference, so that some other system or some modification must be employed for selective or tuned transmission.

"The methods of discrimination or tuning now employed in almost all systems depend on the principle of the superposition of small motions. In wireless telegraphy, tuned systems, and, indeed, long-distance transmission in general, depend on this phenomenon. The moving masses are masses of electricity, and the dimensions regulating their frequency of oscillation are the inductance, capacity and resistance of the circuits in which they move. Thus, if a series of small electrical impulses or waves arrive at a receiving station, each impulse being timed so as always to increase the motion of electricity in the receiving conductors, an oscillatory current will be generated of rapidly-increasing amplitude, which stores up the energy arriving until the current becomes great enough to actuate the receiving mechanism. The most obvious application of this principle to telegraphy is the discrimination between a group of sending and receiving stations by giving the members of each pair, which are intended to communicate, the same electrical dimensions, so that a transmitter, and the receiver it is intended to communicate with, have the same natural frequency. This plan has been adopted by almost all inventors, and works well. The principle has been wonderfully developed, the most strikingly successful result being that obtained by Capt. Jackson, R.N., who this year, while receiving messages from a ship at a moderate distance on the mainmast of H.M.S. *Vernon*, was simultaneously transmitting messages from the foremast to another vessel 500 miles off. This result was rendered possible by an alteration in the original Marconi receiver, which, though apparently small in itself, was of far-reaching importance. In the old receiver the coherer formed a gap of enormously high resistance between the aerial and earth wires which effectually prevented any oscillation in the receiver except the small current which might occur through the coherer plugs acting as a condenser. The coherer was simply cohered by the voltage produced in the aerial. In the new receiver the aerial wire was connected to earth through the primary of a small transformer, thus providing a path of low resistance in which oscillations could grow in amplitude as the impulses from the transmitter arrived, and a secondary circuit which could be made exactly equi-frequent with the oscillations arriving from the distant station. It rendered discrimination practicable, while at the same time it enormously increased the distance over which transmission could take place, by utilising the energy of all the waves arriving instead of only that of the first. The transmitter was next improved by the introduction of more capacity and inductance, enabling it to give out a much longer train of waves, of which, perhaps, 30 or 40 are of useful amplitude, instead of two or three in the earlier form.

The oscillations required for tuning may be produced by various methods, that most generally employed being the use of a separate circuit, as devised by Tesla. Dr. Murray describes the modifications as made by Lodge, Muirhead, and Marconi, and in general he divides the transmitters into two classes: those in which the natural oscillation frequency of the aerial wire is utilised; and those in which the oscillation in the aerial is a forced one, its frequency being determined by a very persistently oscillating circuit coupled to the aerial.

At Poldhu and in his other transatlantic stations—the most recent being that in course of erection near Roundstone, County Galway—Mr. Marconi employs a large number of aerial wires, arranged like an inverted pyramid, all being connected at the vertex to the generating circuit and to earth. A very large electrified surface and capacity is thus obtained with the use of a very moderate quantity of conductor. At the same time the electric lines of force commence at a considerable elevation above the earth, thus facilitating their wide distribution and ensuring a sufficiently long wavelength. The wires are spread out, which gives a free path for the lines of force from each to earth, giving practically a greater capacity to the system than if they were bunched together, in which case the inner wires of the bunch would be nearly useless. The generating system contains a Tesla circuit operated by an alternator and coupled to the aerial. The receiver generally used for long distances is the form of magnetic detector, based on Rutherford's experiments and designed by Mr. Marconi. This receiver is very sensitive, and, as it contains a completely closed circuit, should be susceptible of very accurate tuning leading to a further increase of sensibility.

"Mr. Fessenden uses a single aerial conductor, a great sheet iron tube like a factory chimney about 420 ft. high. Long trains of waves of what may, for wireless telegraphy, be called low voltage, are transmitted, and receiver and transmitter have frequencies which are very exactly equalised. The transmitter to be used for transatlantic work is apparently that most recently patented by Mr. Fessenden. It is practically an alternator with one terminal connected to the aerial and the other to earth. Possibly other circuits may be introduced, but no information has so far been published. The advantage of this transmitter is that an indefinitely long train of waves of equal amplitude may be emitted. If the receiver be exactly equi-frequent, the energy of each wave may be very small as their effect is cumulative. Another patent of Mr. Fessenden's describes a system in which two trains of waves of different frequency are transmitted by one aerial, the receiver being only actuated when waves of both frequencies are simultaneously received. This system opens up great possibilities in regard to discrimination between different stations, as the combinations of two variable quantities—*i. e.,* the frequencies of both sets of oscillations—are involved instead of only the frequency of one set. A similar system has been patented by Braun.

Dr. Murray reviews some of the recent patents, including those of Artom, Marconi, and Blondel, and discusses the action of the coherer and the transmitter. In this latter connection he calls attention to the fact that modern wireless telegraphy is not true radiation, since the Hertzian waves, unguided through space are nearly all lost by passing out into space, and have been used for telegraphing over distances of only a mile or two. When Marconi connected the lower ball of his Hertz radiator to the earth he made the whole earth the lower ball. This made the earth and the aerial the two conductors of an oscillator which is so unsymmetrical that it radiates very little indeed, the oscillations simply spreading from their point of generation over the two conductors.

"The propagation of a hemispherical electric wave, in which the lines of force have their ends on a conducting plane surface has been investigated by Heaviside, and from a wireless telegraphist's point of view by Blondel. Neglecting the curvature of the earth, the form of the wave is approximately the same as would be produced by removing the earth and putting another wire downwards from the spark-gap, this wire being equal in length to the aerial, and oppositely charged at every moment. If the electric wave used in wireless telegraphy retained this form we should find that the currents resulting from their action on the receiving aerial would vary inversely as the square of the distance. This does not, however, agree with Duddell and Taylor's measurements—the only definite measurements as yet published—of the variation of the received current with distance. They find from experiments made between a station at Howth and H.M.T.S. "Monarch" in the Irish Channel, that the current at distances beyond 10 or 15 miles varies in almost exactly simple inverse proportion to the distance between the stations. This result admits of no question, the experiments having been carried out most carefully and with wonderfully concordant results. We must, therefore, accept the fact and look for an explanation in some circumstance which modifies the hemispherical waves given out by the transmitter when they attain a radius of about 10 miles.

"I find that there is an explanation lying ready to our hand, which is based, not upon theory, but on the well-ascertained facts of the nature of our atmosphere. Put briefly, it is as follows: If the earth were surrounded by a spherical shell of conducting material it is a well-known fact that the waves would not die away in proportion to the square of the distance, but would vary, for moderate distances, in inverse proportion to the distance itself. Now, recent researches on auroræ by Danish observers have proved that these occur sometimes as low as 6 miles above the earth's surface and never at a greater height than 60 miles. An aurora is an electric conduction current; hence the layer of air between 6 and 60 miles above the earth is conductive. Here we have, then, the explanation of Duddell's law of variation with distance. The approximately spherical wave given out by the oscillator rises till it touches the conducting layer, then becomes annular, and travels outwards with a wave-front, the area of which no longer increases as the square of the distance, but only in proportion to the distance itself, since the wave is confined by the parallel conducting surfaces above and below. Thus the only space variation which causes diminution in strength is the increasing radius. There is, of course, in addition, a frictional loss of energy."

Dr. Murray concludes his paper by an examination of the phenomenon of the great range of transmission by night than by day, showing that this must be due to some variation of the electrical properties of the atmosphere by the rays of the sun.

MECHANICAL TIME KEEPERS

THE USE OF MECHANICAL RECORDING DEVICES IN SECURING ACCURATE RECORDS OF TIME CHARGES UPON TECHNICAL OPERATIONS.

Henry Abbott—Telephony.

WITH the general introduction of modern cost-keeping methods the necessity for securing accurate and indisputable time records has become fully appreciated. This is true of many branches of industry, but in no department of work are such records more essential than in the telephone exchange. In the early days of telephony the system of yearly subscriptions, worth an unlimited number of calls, was generally employed. With the development of the long-distance service the method of charging by separate tolls became necessary, the toll depending upon the distance and upon the time the wire was in use, the time element originally being computed upon five-minute intervals.

At first the time charges were taken by the attendant at the central exchange, simply by observing the clock and noting the times of the beginning and ending of the conversation, these observations being checked by comparison of the records at both the transmitting and the receiving stations. As the business extended it became evident that some better method was necessary, both as a matter of operative economy and to secure indisputable accuracy. In an article in a recent issue of *Telephony,* Mr. Henry Abbott discusses the introduction into the telephone service of the calculagraph, the time recording instrument now widely used for the purpose of making the time records for telephone calls.

The use of mechanical time-recording devices is by no means new, and many varieties of such apparatus have been made and are in use. Probably one of the best-known forms is the ordinary time-stamp, which simply notes the actual hour upon a card, envelope, or piece of paper upon which the stamp is impressed. Such instruments are now very generally employed in clubs, hotels, and similar places to establish beyond doubt the hour at which a call has been made or a message received, and in this way a fruitful source of errors and complaints has been eliminated.

A further extension of the same idea appears in the different kinds of time recorders for use in manufacturing establishments for checking the time of the arrival and departure of employees, and there are few workshops of importance where such recorders are not found. In fact, many modern establishments have mechanical time recorders placed in each work room, thus subdividing the records, and enabling them to be examined more intelligently, while many mercantile establishments, both wholesale and retail, use the same method of accounting for the time of their employees.

A number of years ago the idea was suggested, by Mr. W. S. Rogers, we believe, of using the mechanical time recorder in connection with the determination of time charges on job tickets, the ticket being passed through the machine or under the time stamp when the work was given out, and again when the finished job was turned in, the difference between the two times showing the elapsed time in a manner beyond any juggling by the employee. The sum of the times recorded against any workman should agree within a reasonable degree of closeness to the total time of the man on the pay-roll, and any great discrepancy would indicate time wasted between jobs.

In the case of the telephone record, however, something more was required, and the instrument devised by Mr. Abbott for this service, and described at length in his paper, records not only the precise hour at which a lever is pulled, but also the elapsed time between a first and second manipulation, the machine performing the subtraction automatically. This does away entirely with any human intervention, and removes the personal element altogether, the work of the operator being limited to the insertion of a card into the instrument and pulling a lever, this operation being repeated at the termination of the service. For telephone work the calculagraph is graduated to read to single minutes in recording the elapsed time, but such a degree of precision is not necessary for shop job records, and the graduations may be modified to suit the service.

There is much to be said in favor of such mechanical time-recording devices, and for all operations which are conducted strictly on a time basis a machine is preferable to any human timekeeper. A mechanical record is free from bias, error of judgment, or favoritism, and apart from the saving in the time of the operator or workman it practically removes all source of dispute or disagreement. Records which can be accepted as wholly reliable may be used with confidence in readjustments of rates or methods, while processes and systems of work may be tested beyond the reach of prejudice or doubt when the timing is performed independently and mechanically.

The widespread introduction of such mechanical time recorders is testimony to the acceptance of the modern theory of production, that human effort is to be directed, as much as possible, toward the direction and guidance of operations performed by machinery, everything of a mechanical nature being performed mechanically, so far as possible, reserving for man the exercise of judgment and discretion.

THE LAKE SUPERIOR IRON-ORE DEPOSITS.

EXPLORATION AND DEVELOPMENT WORK ON THE IRON-ORE RANGES OF THE LAKE SUPERIOR DISTRICT IN 1905.

Dwight E. Woodbridge—Iron Age.

WITH the close of the year 1905 there has come the usual review of the various natural resources of the United States, and among these there is none more impressive than that relating to the iron-ore supply of the Lake Superior district. From this district the United States Steel Corporation draws the greater part of its supply of raw material, while upon the control of certain portions of these ranges depends in great part the ore-carrying business of large railway inteests. In recent issues of the *Iron Age* the trade of this district is discussed by Mr. Dwight E. Woodbridge, a review being given of the output for the past year, together with an indication of the developments.

During the year 1905 the shipments from the district reached 34,000,000 tons, being more than 12,000,000 tons greater than those of the preceding year, a gain of about 57 per cent., or a gain of more than 60,000,000 gross tons in excess of the greatest previous year. Of this enormous tonnage more than 20,000,000 came from the Mesaba range, the balance being divided among the Menominee, Marquette, Gogebic, Vermillion, and Michipicoten ranges.

"The vast tonnage shipped in the past season was seemingly so easily moved and sent forward with so little friction that it is difficult to believe that in no year during the life of the Mesaba range had there been such obstacles to the free movement of ore from mines, nor had the mining companies and railroads ever worked under such difficulties and discouragements. As the Mesaba range furnished about 60 per cent. of the total ore moved to lower lakes in 1905 any derangement there had an effect far more than ordinarily important and far reaching. Time after time during the entire summer there were disastrous floods; the heavens seemed to open and pour out upon the heads of the struggling operators such rains as had never been known. Time after time were the open pit mines of the range—those very properties upon which the mining companies had depended for their great shipments—buried so deeply in lakes and rivers of water that even the booms of the steam shovels were invisible. For three months these floods succeeded each other with a disgusting regularity and frequency.

"Shipments for single railroad systems were extremely large. The Duluth, Missabe & Northern, which serves mines upon a portion of the Mesaba range, handled to its docks in the month of July, 1,408,000 tons, or 50,000 tons per day, and averaged during the entire season of navigation better than 1,000,000 tons each 30-day period. The Duluth & Iron Range, serving the entire Vermillion and a portion of the Mesaba range, moved during the year a trifle below 1,000,000 tons per month, while the Chicago & Northwestern, with docks at Escanaba and Ashland, had a gross business at both points of about 6,000,000 tons. A departure in traffic conditions was made during the fall by the Wisconsin & Michigan Railway, which opened its ore line to points on the Menominee range, hauled ore from mines to docks at Peshtigo on Lake Michigan and transported it from there to furnaces at Chicago and elsewhere on modern car ferries, each capable of carrying a train of loaded cars. The innovation of utilizing ferries to move loaded trains, thus obviating ore piers and saving 280 miles of railroad, which was replaced in this company's scheme by the free highway of Lake Michigan, is an interesting method of long distance transit. The car ferry for crossing great lakes and for moderate distances has long been in favor, but this is the first time any such system has been adopted in lieu of main line long distance traffic, and the result will be watched with some interest."

In view of the rapid development which is being made in the district it is interesting to observe that some of the independent interests are acquiring ore reserves, so that the whole region is by no means controlled by the Steel Corporation. Thus, the Hill interests, including those of the Great Northern Railway, hold a number of important leases, including the Mahoning mine, estimated to be capable of producing 1,000,000 tons a year for 60 to 75 years, but this, and other mines, classed as Hill holdings, are really leaseholds, thus being valuable payers of royalties, and furnishing profitable hauling, but not open for disposal during the life of the leases.

"Exploration during 1905 has been more general than for some time. It has not been confined to the Mesaba, but has extended to the once-promising Vermillion, to the Menominee and to parts of the Marquette and Gogebic ranges. Deep shaft sinking on the last named range is opening ore deposits that give the brightest promise for the future, a promise of maintaining the output of the district at a steady price for many years. Drilling on parts of the great ore bearing formations of the Menominee range is opening a few mines of importance and is giving hope for more. Though immense sums have been spent in the Vermillion in past years with the diamond drill no large deposits have ever been found aside from the Soudan and Ely groups. Now a number of drills are at work elsewhere. On the famous Section 30-63-11, where drill work had been carried on for three years, a shaft is now dropping slowly through the hard jasper and iron formation of that difficult region. At this prospect some ore has been found, and it is probable that the deposit may pan out as a very fortunate discovery.

"In what is known as the Austin, Swanzey and Palmer districts of the Marquette range explorations during the year have revealed what may be of great importance. There are in these districts immense bodies of low grade ores, highly silicious, some well within the Bessemer limit as to phosphorus and others highly in that element. Hundreds of millions of tons of fair ores are known to exist about Palmer, as well as in other parts of both the Marquette and Menominee ranges, which will be wanted in due time and are advantageously located as to freight charges."

Among the new districts in which developments may be expected, Mr. Woodbridge notes the Deerwood or Cuyuna range, about 100 miles west of Duluth, the Baraboo range, and the Atikokan range, in western Ontario, while he states that steps have been taken for the immediate development of the Moose Mountain region, north of Georgian Bay, in Canada, where there are large deposits of magnetite.

"In preparation for the operations of 1905 as well as for 1906 an enormous quantity of dead work has been carried forward. On the Mesaba range alone stripping contractors and mining companies have moved in 1905 above 6,000,000 cubic yards of overburden, one contracting firm alone removing more than 2,600,000 yards. On this range the evolution from underground to open pit, before referred to, has been general and with accelerated speed. It is now no bar to stripping that a mine is covered by 100 feet of overburden of boulders, hardpan, drift or ledge. It is all rolled back and carried off, providing the ore deposit is of sufficient thickness to make the subsequent mine operations economical. Many a Mesaba mine which has been operated underground from the beginning is to be stripped; indeed, many have already been changed from one system to the other. The Oliver Iron Mining Company alone is buying this winter an additional stripping and mine equipment of 65 standard gauge locomotives and 25 steam shovels, which is an indication of its plans for changing to open pit and mining by shovel. There will be, at the opening of 1906, not less than 120 heavy steam shovels working on this range."

With all this development in the iron ore trade there naturally follows preparations to handle this enormous tonnage on the lakes. It has been estimated that for the five years ending with 1910 the average shipments may readily be 40,000,000 tons per year as against 25,000,000 tons for the preceding five years. This means that the 4,000 to 5,000 ton boat will be replaced by carriers of 10,000 to 12,000 tons, reaching 600 feet in length, and constructed with the combined experience of both the owners and lake shipbuilders.

ENGINEERING EFFICIENCIES.

THE PRACTICAL MEANING OF EFFICIENCY AS APPLIED TO THE COMMERCIAL SIDE OF ENGINEERING UNDERTAKINGS.

James Swinburne—Institution of Electrical Engineers.

IN an interesting address, delivered before the students of the Manchester Local Section of the Institution of Electrical Engineers, Mr. James Swinburne talks about the efficiencies of commercial and engineering undertakings, using the term in the plural, as he explains, in order to avoid any possibility of confusion with the term "efficiency" as employed in the parlance of party politics.

Mr. Swinburne is generally to be depended on to state his views in a positive, and even dogmatic way, but he has a refreshing frankness about it which makes interesting reading, even when the reader does not always agree fully with his views. It seems very desirable, for instance, that the precise technical meaning of the term "efficiency" should be settled and accepted, but this happy conclusion has by no means yet been attained, and we have the German engineers disputing about the true meaning of *wirkungsgrad,* while the French *rendement* has to be qualified in nearly every case to make sure that the writer's meaning is conveyed. In any case, however, there is no doubt that each one of these terms conveys the idea of a ratio, expressible as a percentage, so that the points usually under discussion are those relating to the quantities between which the ratio is taken, and in this respect Mr. Swinburne makes himself clear, even when he boldly announces his unorthodoxy.

Mr. Swinburne says that the term efficiency is used by serious people to denote the rate of the useful part of the energy or power obtained, to the energy or power put in, which is indeed true, but there are various differences of opinion as to what portions of the result are to be considered as useful, and hence corresponding differences in the value of the numerator of the fraction. This difference of opinion is brought out by Mr. Swinburne at the start, since he says that in a well conducted bargain each of the parties gives what he prefers to part with for what he wants more, so that both are satisfied. If each man gets out more value than he puts in each gets an efficiency of more than 100 per cent. out of the trade and, as Mr. Swinburne again says, it is not quite usual for a bargain to have an efficiency of more than 100 per cent. from each point of view. However, from the Oriental viewpoint it has been said that a profit of 10 per cent. is understood to mean the sale of an article for ten times what it cost the seller, so that a preliminary statement of the writer's point of view is almost necessary if his position is to be understood. Fortunately Mr. Swinburne explains what he means as he goes along, which is quite convenient.

After discussing a few examples of efficiency in monetary transactions, Mr. Swinburne proceeds to some technical examples of efficiency.

"In making any bargains with Nature, we always lose in a sense; and we are so accustomed to it that we take it quite contentedly, and merely try to lose as little as possible in the transaction. As I said before, the relation of what we do not lose to the whole is termed the "efficiency." In dealing with our fellow men we always hope to make a profit, and we sometimes do. In such a case it might be correct to talk of an efficiency of over 100 per cent., but it would be unusual. It might be still more unusual to say a bankruptcy which resulted in a payment of 6s. 8d. in the £ was a transaction with an efficiency of 33 1/3 per cent. But there would be enough justification for such a proceeding to enable me to discuss some aspects, even of electrical commerce, under the head of efficiency.

"Heat includes what is called sensible heat, or heat that makes things hot; latent heat, such as the heat that disappears when ice is melted or water vaporised at constant temperature, and chemical energy. I must tell you that it is not orthodox to call chemical energy heat; and you will not find any such treatment of the subject in books on thermodynamics. At present I believe I am alone in classing chemical energy or defining heat so as to include chemical energy; but the treatment of chemical energy in chemical thermodynamics is quite consistent with my definition, so I may use it provided I give you due warning of any heterodoxy. I think that it is not realised that chemical energy is necessarily low-grade energy, only partially convertible into work. This involves the idea of chemical temperature which may be important in chemistry in discussing the way any given possible reaction will go; but we are not concerned with that here. It will be said that the coal is cold when it is put into the furnace, as cold as the air in fact; so that if this idea is right none of the chemical energy is available. But I must give some idea of what I mean by chemical temperature. If carbon and oxygen are heated to a high enough temperature you get a state in which on the least fall of temperature the carbon and oxygen combine and give out sensible heat at that temperature, under the other circumstances that obtain. The least increase of temperature, however, causes the carbon and oxygen to separate again, absorbing sensible heat. At this temperature, therefore, under the pressure and quantitative relations of the carbon, oxygen, and carbon monoxide, sensible heat and chemical energy are interchangeable. This temperature may be called the chemical temperature of the energy of carbon and oxygen.

"It might be supposed that there is enormous room for improvement in the steam engine. An efficiency diagram looks as if all the loss is due to the engine which gets 68 per cent. and only gives out 7 per cent., but we must not be hard upon the engine. It is turning out work, or high grade energy, and it is receiving heat, or low grade energy. This engine is probably taking in steam at about 450° C. absolute, and rejecting it at about 375° C. A., so it could if perfect only turn out $68 \times 75 \div 450 = 11.3$; so it is not really doing so badly. The real loss is between the fuel and the boiler, and it is not loss of energy, but loss of availability. Though the chemical is low grade energy, it has such a high chemical temperature that 97 per cent. is theoretically available; but we cannot run a boiler and engine between 3,000° C. and 4,000° C. Engineers are always trying to improve the results by using higher and higher temperatures; but as you cannot use the pressures that would then correspond with saturated steam you can only superheat. This does not mean that most of the heat is taken in at the high temperature, and the resulting gain is chiefly due to such things as reduction of cylinder condensation. There are great practical difficulties in reducing the lower temperature. The condenser reduces it to about 100° C. or 373° C. A.; but even then the steam is not completely expanded, and blows into the condenser under pressure."

Mr. Swinburne refers, in passing, to the fact that the temperature of rejection has been lowered recently by the use of a second fluid medium, such as sulphur dioxide, an idea which is as old as the days of Sir Humphry Davy, and which has been tried in various forms since without much success, mainly owing to mechanical and operative difficulties.

An interesting portion of the address relates to the management of municipal electrical undertakings, in connection with which some diagrams are given showing the manner in which the efficiency of the Metropolitan Electric Supply Company's system varies according to the load. This gives Mr. Swinburne opportunity for an interesting disquisition upon the subject of municipal undertakings in general.

"If a station is run by a town the accounts must be kept by an absurd system. Towns are generally concerned with such things as sewage systems, in which there is no profit and loss account. The town may not treat its sewage system as a permanent asset at all. It has to borrow money to put down its sewage system, say £100,000 at 3 per cent. Then it has to pay £3,000 a year interest. But that is not all—it has to pay back the whole £100,000 in a certain number of years. To do this it has to provide out of the rates a sinking fund, such that in the prescribed term of years the whole of the debt is paid off. The town then has a sewage system to the good, which has been paid for over many years out of the rates. The town, therefore, does not save money like the private individual and then buy what it can afford. I do not think that it would be allowed to do such a rational thing; it has to borrow money for everything and pay it back over a term of years. The length of the term has no reference whatever to the nature of the work done, as the work is not in any way security for the loan; the local rates are the security. There is an epidemic of outcry just now about municipal indebtedness, but it is apt to give a totally wrong impression to the average reader, as he does not realize that municipalities must be in debt owing to the way these things are arranged. For a private individual always to be in debt would be bad; for a town it is another matter; the only question is how much the town ought to be in debt. The nation itself does business in the same sort of way; it has no ready money, and when anything has to be done it borrows. But local authorities are now taking up such businesses as electric supply and tramways, which have profit and loss sides, but they are obliged to work the businesses on the same lines as town improvements, which is absurd. A municipal electric light scheme is thus worked under absurd difficulties. It is like a public company that has a negative capital—that is to say, all its money is borrowed. The shareholders are the ratepayers. They hold shares depending on the rate assessments. The dividends are generally negative. All the shareholders are so by compulsion if they live in the place. The only thing they can do if they do not want to be shareholders in such undertakings is to move off to another town; but then they become shareholders in another set of ventures. I believe the only way to avoid being shareholders in these compulsory undertakings it to live in a barge on a canal."

THE GAS TURBINE.

THE PRESENT STATUS OF THE QUESTION OF A PRACTICAL SOLUTION OF THE GAS-TURBINE PROBLEM.

A. Berthier—Le Génie Civil.

ALTHOUGH the gas-turbine problem has been under consideration for several years, and has occupied the attention of a number of able engineers there has been little or no practical progress, at least so far as can be gathered from the detailed results which have been made public.

In a recent issue of *Le Génie Civil* there is given a résumé of the present status of the question on the Continent in a paper by M. A. Berthier. from which some abstract is given as being of present interest. After referring to the fact that piston gas engine and the steam turbine each represent the latest achievements in their respective departments of motive power, M. Berthier sees in the gas turbine a possible union of these two systems, a machine uniting in one mechanism the advantages of both.

The earliest attempt to construct a gas turbine appears to be that of Stolze, of Charlottenburg, who, as long ago as 1873, took out a patent for what may be termed a hot-air turbine. As a matter of fact the ancient mechanism for operating the turnspit, consisting of a sort of propeller wheel on a vertical axis, fitted in the chimney, and driven by the force of the ascending current of hot air and smoke, preceded any other machine of the kind, but we cannot ascertain either the date or the inventor of this early device.

The Stolze turbine consists practically of two turbines mounted upon the same horizontal shaft, the one acting to draw in and compress the air to about 2½ atmospheres, absolute, this compressed air then passing partly through a furnace and partly through a heating chamber, the hot air, mixed with the gases of combustion, passing through the turbine. The available power is the difference between that developed by the turbine and that required to drive the rotary compressor. A turbine of 200 horse power has been constructed on this plan, and experimental trials are being made as to its performance. The Stolze turbine practically follows the same cycle as the ordinary internal-combustion engine: compression, carburation, combustion, expansion, exhaust, the only difference being that the mixture of the air with the combustion is not effected until after the compression, as is the case with the Diesel motor.

Considering the Stolze turbine rather as a hot-air motor than a gas-turbine, M. Berthier passes to the later plans for turbines using gas or petroleum as fuel. These machines are based upon the combustion of the fuel in a closed chamber at constant pressure, the pressure of the gaseous products of combustion being converted into velocity in the turbine nozzle. The designers of such machines have generally assumed that the use of a nozzle and wheel of the de Laval type is practicable, and devoted themselves to the production of a suitable combustion apparatus.

M. Berthier gives, as an example of a combustion chamber for a turbine, a sketch of the Meineke device, this having separate entrances for the air and gas, the combustion taking place at constant pressure, the expansion being effected wholly in the nozzle. M. Meineke advocates the use of a cycle composed of four phases, the heat being furnished and rejected at constant pressure, the expansion and the compression being adiabatic.

It does not appear that any actual operative machine has been constructed on the plan of M. Meineke, but M. Berthier passes to the mixed steam and gas turbine of Armengaud and Lemale, which, as has already been noted in these columns, has been actually built and run. The principal characteristic of this appearance lies also in the combustion chamber. The air and the liquid fuel enter through concentric nozzles at one end, while a circulation of water in the lining of the chamber protects it from destruction by the high temperature.

The supply of cooling water is so regulated that it is raised to the boiling point and delivered in the form of steam to mix with the gases of combustion in the expanding nozzle of the turbine, the wheel of the latter being fitted either with double buckets of the Pelton type or single ones similar to the wheel of de Laval.

By the use of the vapor of water one of the most serious mechanical difficulties is overcome, the gases are cooled to a degree which prevents serious injury to the wheel. In one form of machine the hot gases, after having passed through the wheel, are directed over the tubes of a coil boiler, the steam from which is also discharged upon the turbine wheel through an independent nozzle. A 50 horse power machine of this type has been operated at Saint Denis with such success that an improved one of 200 horse power is being built.

M. Berthier refers to the theoretical analysis of gas-turbine cycles made by Mr. R. M. Neilson in a paper presented before the Institution of Mechanical Engineers about a year ago and reviewed in these columns in December, 1904, and cites the three essential points upon which further experience is required in order that a gas turbine may be scientifically designed. In the first place the losses occurring in the compression of the air to high pressures must be minimised. Rotary compressors are to be preferred, if such can be made of high efficiency, since one of the advantages sought to be realized by the use of the gas turbine is the replacement of reciprocating by rotary motion, and there would be small gain to secure rotating members for the power end if a reciprocating compressor is retained at the other end. We have already seen that Stolze employs a rotary compressor, and it is reported that the new Armengaud and Lemale turbine is to have a rotary compressor of the Rateau type, but details are lacking. Since the total efficiency of the machine depends very greatly upon the efficiency of the compression this is a most important element. Possibly the combination proposed by Mr. Neilson may be found experimentally desirable, this being to use an ordinary gas engine for the compression and preliminary combustion, employing the exhaust gases of the gas engine to drive a low-pressure gas turbine, much in the same manner as M. Rateau uses a low pressure steam turbine to utilize the exhaust from reciprocating high-pressure steam engines.

The second point demanding elucidation is that of the losses occurring in connection with the expansion of hot gases in divergent nozzles. This has already been treated in the leading pages of this Magazine in the issue for April, 1905, by Dr. Lucke, who has also discussed the question in the *Transactions of the American Society of Mechanical Engineers*, and it appears that there is room for a thorough experimental investigation of this important element in gas turbine design.

Mr. Neilson's third point is that of minimizing the losses by radiation and transference of heat from the gases to the metal at the high temperatures at which the parts must necessarily be operated.

In summing up, M. Berthier remarks that whatever the fluid employed, be it water, steam, or gas, the successful operation of impulse turbines depends upon the velocity of the fluid which acts upon the buckets of the wheel. In the cases under consideration this velocity is obtained by passing the fluid from a reservoir at a high pressure through a nozzle into a space at a lower pressure. Dr. Lucke has shown that there is a difference under these conditions, between gas and water; the volume of water is not changed, since it is practically incompressible, while the volume of a gas is increased in proportion as the pressure is lowered, according to the law of Mariotte.

We then have three principal cases:

First, that of non-compressible liquids, such as water. The velocity is that due to the drop in pressure, the density remaining constant.

Second, that of gases. The velocity is that due to the drop in pressure, at constant density, that is, without change of volume, or else it is due to the change of density resulting from change of pressure and temperature.

Third, that of vapors. The velocity is due to the drop in pressure, at constant density; or else to the change in density consequent upon change in pressure, the vapor remaining in the state of vapor; or else to a change of state, caused by superheating or condensation, as the case may be.

Thus, according to the nature of the fluid employed, the velocity due to the pressure may have two sources; it may be mechanical or thermal in its origin. As Dr. Lucke indicates, the thermal increment of the velocity may be either positive or negative, and hence tend to augment or diminish the mechanical velocity. The final velocity, therefore, is not independent of the nature of the fluid used. Since the laws of discharge are not absolutely the same in all cases, it seems as if the form of the nozzle should be modified for the fluid.

The phenomena accompanying the expansion of gases behind a piston in a cylinder have been studied for a long time, but those accompanying free expansion are not so well known. Mr. Neilson urges the importance of experimental investigations in this respect, and the problem is one which may well occupy the attention of physicists.

The gas turbine question includes a number of unsolved problems; but, on the other hand, the available resources for their solution are numerous. It will permit the utilization of air and gas, air and hydrocarbons or alcohol, but also allow the combination of the explosion motor and the steam turbine using highly superheated steam in connection with flash boilers of the Serpollet type. The problem is before the physicist, the engineer, and the machinist, and it will require all their resources to effect a satisfactory solution.

THE PRODUCTION OF OXYGEN.

IMPROVED METHODS OF SEPARATING THE OXYGEN AND NITROGEN OF THE ATMOSPHERE BY THE RECTIFICATION OF LIQUID AIR.

Georges Claude—Comptes Rendus.

THE commercial applications of liquid air have proved to be but limited in number and value, although the liquid itself has proved most useful in laboratory investigations demanding the maintenance of low temperatures, as for example in connection with the study of the behaviour of steels under extreme cold, by the Alloys Research Committee, reviewed elsewhere in this issue. Another branch of research work, which may develop into commercial importance, is the production of pure oxygen by the separation of the elements of the atmosphere, this having been accomplished by several physicists, notably by M. Pictet, and by M. Claude. In recent papers presented before the French Academy of Sciences, and published in the *Comptes Rendus,* M. Claude describes the latest methods which have been devised for this purpose, which will be found of interest.

The early methods for separating the elements of the atmosphere, with especial intention of procuring pure oxygen, were based upon the fractional vaporization of liquid air, but these are now replaced by processes involving rectification. Liquid air, being composed of a mixture of two fluids, miscible in all proportions and of very different degrees of volatility, the possibilities of applying the principles of rectification to this mixture is evident. In fact, this application involves conditions practically identical with those employed for the rectification of mixtures of water and alcohol, with this advantage that the difference in volatility between liquid oxygen and nitrogen is much greater than between alcohol and water, so that the operation in this latter case is extremely effective. Thus alcohol boils at about 80° C., and water at 100° C., a difference of 20 degrees, while the boiling point of liquid oxygen is —181° C., and of nitrogen —194° C. This difference of 13 degrees, however, is much greater than really appears, for the importance of the degrees on the thermometric scale increases with great rapidity as the absolute zero is approached, and 13 degrees at the point of liquid air are equivalent to about 60 degrees at the temperature of the boiling point of alcohol.

M. Claude describes first the method of rectification suggested by his assistant, M. René Lévy, this utilising the vaporisation of the liquid oxygen to furnish the cold to aid in liquefying air already compressed to 4 or 5 atmospheres. This system included the use of a rectifying tower, placed above the vaporiser, this utilising the counter-current principle to permit the ascending current of oxygen to be condensed by the descending liquefied air. In a modification of this apparatus M. Claude has succeeded in repeating the rectification effect in such a manner as to separate the oxygen wholly from the nitrogen, furnishing pure oxygen for scientific and commercial purposes, and consequently also delivering pure nitrogen, this being of great value for the manufacture of ammonia and the cyanides. In this system the cold produced by the evaporation is utilised for the production of a fresh quantity of liquid air, so that the method is brought within the commercial limitations of actual trade. The apparatus at present employed by the liquid air company, at Boulogne-sur-Seine, is capable of producing 1,000 cubic metres of oxygen, of 96 to 98 per cent. purity in twenty-four hours at a cost of one-twentieth that required for the electrolysis of water.

Among the practical difficulties which have been encountered in the perfection of the process that of the lubrication of the apparatus has not been the least. M. Claude describes the use which has been made of ether and petrol for lubricating purposes, but he has discarded both of these by using the liquid air itself as a lubricant, this simplifying the whole apparatus, and assuring a perfectly satisfactory operation.

The uses of pure oxygen and pure nitrogen in the arts have already been anticipated, and it is only the question of costs which are to be considered. M. Claude announces that he is about to place both of these products upon the market, and this being the case it should soon be possible to determine the extent to which such appliances as the oxy-hydrogen and oxy-acetylene blowpipes are to become tools within the reach of every machine shop. The manufacturing chemist will hail the supply of pure nitrogen as a welcome addition to his materials of production, and thus the much discussed value of liquid air in the arts will be determined, at least for the present. The electric furnace has placed the control of extremely high temperatures in the hands of the physicist and the engineer and the practical production of liquid air has given him command of the lower end of the temperature scale. The uses which he shall make of these resources depends wholly upon himself, and there is every evidence to show that he is not wasting his opportunities.

NICKEL ALLOY STEELS.

THE MECHANICAL, PHYSICAL, AND CHEMICAL PROPERTIES OF THE IRON-NICKEL-MANGANESE-CARBON ALLOYS.

Alloys Research Committee—Institution of Mechanical Engineers.

THE reports of the alloys research committee of the Institution of Mechanical Engineers have been welcomed by engineers and physicists as valuable contributions to our stock of knowledge of the materials of engineering. The seventh report, recently presented and discussed at meetings of the Institution, is devoted to the nickel-manganese alloys, this including certain iron-carbon alloys containing both nickel and manganese. The report bears the names of Dr. Carpenter, Mr. Hadfield and Mr. Longmuir, the actual research work having been performed at the National Physical Laboratory upon specimens furnished by Mr. Hadfield.

As the researches covered by the report were intended to determine the influence of the nickel content of such alloys it was decided to make the proportions of the other elements as nearly constant as possible. The base of the specimens was a Swedish charcoal iron of especial purity, this being melted with the ingredients nickel and Swedish white iron, the intention being to secure approximately uniform percentages of carbon and manganese, with percentages of nickel varying from zero to

20 per cent. According to the chemical analyses of the actual test pieces the carbon content varied from 0.40 to 0.52, it being intended to have a carbon of 0.45 per cent., while the proportion of manganese ranging from 0.79 to 1.03, this being a particularly difficult element to maintain at a constant proportion, owing to losses in melting. The material was cast into ingots, one-half of each ingot being forged down to a round bar, from which test pieces were taken; while the other half was machined into an additional set of test pieces, both annealed and unannealed.

The influence of nickel upon steel is generally regarded as tending to raise the elastic limit and the ultimate stress without seriously impairing the ductility, these properties, as pointed out by M. Guillet, depending also upon the carbon content. Earlier experiments upon nickel-manganese steels in which the carbon content was only about 0.17 per cent. have demonstrated the existence of a brittle zone, the members of which possessed a high tensile strength and low ductility, while above and below this zone the alloys were comparatively ductile.

The tests conducted by the present investigators were made on specimens normalised by heating to a temperature of 800° C., this temperature being found to clear safely the critical ranges of all the alloys under consideration; the annealing being done in a muffle and the temperature taken by a thermo-couple. The annealed test pieces were subjected to bending, tensile, torsion, and compression tests, the results being fully tabulated in the report and also plotted in curves. Impact tests and tests for hardness were also made and specimens were subjected to tensile tests at the temperature of liquid air, in order to furnish a continuation of the previous researches of Mr. Hadfield in this direction.

The general results of the mechanical tests may be summarized as follows:

"With the increase in nickel content up to 4 per cent., the change in properties is gradual; the material, when under elastic stress yields more to the stress; at the same time, after the apparent yield point is passed the maximum stress increases. Although the change in properties is gradual there is in nearly every case a more or less pronounced kick in the curves between 0 and 4 per cent. nickel. At some point between the percentages of 4.25 and 4.95 nickel there is a very sudden change in nearly all of the properties, evidenced by a rapid increase of maximum stress, which reaches the highest value at 6.42 nickel, a fall of ductility, and an increase of brittleness as shown by the bending, tension, torsion, and shock tests. Thus, as far as industrial products are concerned, a danger limit for nickel content is found at 4.25 per cent., when carbon and manganese are present to the extent of 0.44 per cent. and 0.88 per cent. respectively.

"After this sudden break in the curve the various properties alter more slowly again until a percentage somewhere in the neighborhood of 16 is reached, i. e., the brittle zone extends from about 5 to 16 per cent. From this point on the change is more rapid and in the reverse direction to the original rapid change."

The tests of the cast material gave results following generally the same order as those of the forged material, the maximum tensile strength being represented at a content of 7.95 per cent. nickel. Singularly enough this maximum is associated with an elongation of 4.5 per cent., and the three steels which in the forged condition are distinctly brittle, show in the cast normalized state elongations of 6.2 per cent., 4.5 per cent., and 6.2 per cent. These remarkable and unusual results find some analogies in other alloys. Thus the alloy containing 9.51 per cent. nickel, and 0.18 carbon, when subjected to the bending test, in the forged state, fractures at an angle of 5 degrees, while the same steel in the cast annealed state bends to an angle of 8 degrees. Similar results were obtained with an alloy containing 11.39 per cent. of nickel and 0.18 carbon, this steel, in bending, reaching an angle of 9 degrees when tested in the cast condition, while in the forged state fracture occurs at 3 degrees. The last two cases are taken from Mr. Hadfield's previous researches upon low carbon nickel-manganese steels.

The tests conducted at the temperature of liquid air show that these alloys are well adapted to be used at low temperatures. In every case there is an increase in tenacity at the low temperature over that at ordinary temperatures. A remarkable increase is shown by the alloy containing 20 per cent. of nickel. At ordinary temperatures this steel shows a tensile strength of 43.9 tons per square inch, while at the temperature of liquid air, —182° C., the resistance rises to the remarkable figure of 157.2 tons, with an elongation of 15.5 per cent.

This 20 per cent. alloy is a remarkable one in various ways, having a very high degree of ductility, giving an elongation, at atmospheric temperature, of 55 per cent., and a reduction of area of 63.11 per cent., an ultimate strength of 43.9 tons, and a yield point of 15.33 tons.

The physical, chemical, and metallographical properties of the alloys tested are discussed at length in the report, including resistivity, permeability, specific gravity dilatation, and corrodibility, and there are also tables and diagrams of the critical ranges on heating and cooling. A very complete series of micro-photographs of the special alloys are shown in the illustrations to the report, these accompanying a discussion of the metallography of the alloys.

Taken as a whole this seventh report of the Alloys Research Committee is a worthy companion to its predecessors, and as a record of scientific research and a source of practical information it is to be commended.

ENGINEERING IN 1905.

A REVIEW AND RETROSPECT OF THE WORK IN VARIOUS DEPARTMENTS OF ENGINEERING DURING THE PAST YEAR.

The Engineer

IT has been the custom of our valued contemporary, *The Engineer,* to prepare each year a comprehensive review and retrospect of the progress of the past year in the principal departments of engineering, and such studies are always of value, both for their historical interest and for their service in future conduct of affairs. While this review is naturally prepared from the British viewpoint the engineering interests of Great Britain are so extensive that the progress of the art of the engineer in all parts of the world is necessarily included, and an excellent international and cosmopolitan review is thus found.

Broadly the year 1905 was a record one in several departments of industry. The coal output of the world, rightly regarded as a gauge of the manufacturing industries, was the heaviest ever known. In Great Britain the shipbuilding industry beat its previous records, while in the United States, as we have noted elsewhere, the production of iron again passed the maximum of previous years. The motor-car industry continues to grow, and the electrical manufacturing establishments maintain their activity. In Europe political uncertainties have done much to cause certain departments of trade to be held in suspense, notably in connection with the affairs of the Russian Empire, while the conclusion of peace in the Far East will naturally be followed by rapid internal industrial developments in Japan.

Taking up the various departments of engineering, it appears that there have been no great developments in mechanical engineering, the time having rather been one of steady development than of origination. Railways are increasing the weight of rails and the power and speed of locomotives, and the capacity and materials of cars have alike been improved, steel cars coming in for favorable consideration for both freight and passenger service. In marine engineering the turbine has extended its scope, the Carmania, with 20,000 horse-power, having been put into service, while work on the 70,000 horse-power machines for the new Cunard liners is progressing.

In reciprocating-engine design the principal new feature appears to be the drop-piston valve. Late tests have shown that a portion of the loss usually attributed to cylinder condensation may be due to leakages almost impossible of prevention with flat slide valves. By the employment of the drop piston valve, and the use of superheated steam, the steam consumption has been lowered to 8.6 pound per horse-power per hour. In connection with the use of superheated steam it has been shown that it is difficult to carry it in pipes for even a moderate distance without loss, and hence the engine should be placed as close to the boilers as practicable. In Germany the best results have been secured with semi-portable engines, the engine being placed on the top of the boiler, and the highly superheated steam conducted directly to the engine without exposed piping.

The conspicuous development of the year has been in the department of internal-combustion engines. There has been no notable improvement in the engine itself, but the rapid progress which has been made in the introduction of the suction gas-producer system is responsible for much increase in business. Thermal efficiencies of 24 per cent., and commercial economies represented by costs of only one-twentieth of a penny per horse-power per hour, show what has been accomplished, while manufacturers both in Europe and America are busy with orders. The large gas engine has taken its place as an acceptable article of manufacture, and is now wholly out of the experimental stage. The gas turbine remains an object of interest and curiosity. Such few machines as have been made remain in the privacy of the experimental testing laboratories of their makers, and theoretical discussions, such as that appearing in this Magazine, in April of last year, from the pen of Dr. Lucke, have been studied only to confirm the opinion that no higher economy is to be expected than with the reciprocating type of machine. If the turbine is to become an effective form of the combustion motor it will probably because of its mechanical advantage rather than its possible thermal efficiency.

The automobile business is gradually emerging from the domain of sporting appliances into that of solid commercial manufacture. In certain directions the craze for high-powered high-speed cars continues, but the later trials which have attracted interest have been in connection with endurance and commercial efficiency. The motor omnibus is demanded, and the demand is gradually being supplied, while delivery wagons, and moderate-powered family and professional vehicles are beginning to receive the attention which they should have had long ago. The motor boat is in a similar stage of development, but is yet mainly in the sporting stage, although a number of useful applications have already been made in connection with the provision of auxiliary power for fishing vessels and motive power for naval launches.

Machine tools are in a state of transition. The advent of high-speed steels has created a demand for machines capable of operating to advantage under the new cutting speeds and feeds, but this demand is not to be met by tools which are merely larger, heavier, and more highly powered than to older ones. Many manufacturers have preferred to strengthen their old tools and await the arrival of machines of entirely new design, and until such are forthcoming this industry cannot be expected to keep pace with its changed conditions.

Civil engineering enterprises in 1905 include great irrigation works, both in the United States and in India, while new bridges, both of stone and masonry, continue to be built. The masonry arch still maintains its supremacy for situations where its construction is practicable, while cantilever and braced-arch bridges hold the preference for structures of steel.

The growth of municipalities is accompanied by increased demands for better water supply, improved sewage and refuse disposal systems, and greater transport facilities. In London the electrification of the underground railway is a matter for comment, while in New York the year-old subway is already strained to its maximum carrying capacity. The water supply of Paris is demanding extension and improvement, while a long list of cities in various parts of the world gives indication of the extent to which the demand for better water supply exists.

Early in the year the headings of the Simplon tunnel met, and confirmed the accuracy of the surveys, and by May of the present year the new passage through the Alps is expected to be opened for traffic.

Altogether there has been a great mass of most excellent engineering work completed in 1905, while the new works projected and under way may be credited partly to the year which is past and partly to that which is now fairly begun. In all that has been undertaken the engineer has fully maintained his position as the man who directs the great forces in Nature to the use and convenience of man.

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

The New Steel Arch Street Bridge Across the Potomac River, Washington, D. C. Illustrated detailed description of an interesting bridge under construction, at a cost of $375,000. 2000 w. Eng News—Dec. 21, 1905. No. 73979.

The Plano Arch. John P. Hazen Perry. Illustrated description of the construction of this bridge on the C. B. & Q. R. R., in Illinois. A concrete arch of 75 ft. clear span with wing walls giving a total length of 210 feet. 3000 w. Harvard Engng Jour—Nov., 1905. No. 73742 D.

The Pont de Commerce at Liége (Le Pont de Commerce à Liége). Th. Seyrig. The bridge consists of twin steel voussoir arches, the thrusts at the middle pier balancing each other, leaving only a vertical component. 8000 w. 2 plates.

Mem Soc Ing Civ de France—Oct., 1905. No. 73882 G.

Denver.

Lawrence Street Bridge, Denver. Illustrated description of a highway bridge 74 feet wide and 156 ft. long, consisting of two plate girder spans skewed 42 degrees 10 minutes with their abutments. 1000 w. Eng Rec—Dec. 2, 1905. No. 73575.

Drawbridge.

A Temporary Bridge with Pontoon Draw Span Over the Chicago River. Illustrates and describes an interesting temporary structure near 22nd St., Chicago. It is a pile trestle with a swing span having one end supported by pivot on the fixed work, and the other end supported by a fixed bearing when closed and by a pontoon when swinging. 900 w. Eng News—Dec. 28, 1905. No. 74034.

Trunnion Bridge for W. & L. E. R. R. at Cleveland. A fully illustrated description of an improved type of lift drawbridge, with trunnion supports and counterbalanced leaves—replacing an old swing railroad bridge over the Cuyahoga river. 2500 w. Ry & Engng Rev—Dec. 16, 1905. No. 73783.

Girder Bearings.

Standard Bearings for Long-Span Plate Girder Bridges, Chicago, Milwaukee & St. Paul Ry. Illustrates and describes the character of the end bearings used. 1200 w. Eng Rec—Dec. 9, 1905. No. 73676.

New York.

Terminals of the Manhattan Bridge. Outlines the general design of the bridge and illustrates both terminals. 600 w. R R Gaz—Vol. XXXIX., No. 22. No. 73544.

The Upper Sections of the Manhattan Bridge Towers. Illustrates and describes details of towers, the scheme of horizontal bracing, &c., of the Manhattan bridge in New York City. 1000 w. Eng Rec—Dec. 2, 1905. No. 73571.

Paris.

The Austerlitz Bridge Across the Seine for the Metropolitan Railway of Paris. René Bonnin. States the conditions to be met and gives an illustrated description of the plan adopted, and method of erection. 4000 w. Eng News—Dec. 7, 1905. No. 73627.

Trusses.

The Theory of the Longitudinal Connections of Iron Bridge Trusses (Zur Theorie der Längsverbände Eiserner Fachwerkbrücken). Dr. Alexander Coulmas. A mathematical examination of the action of the various forces on longitudinal connections for different loadings. 7500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 2, 1905. No. 73873 D.

CONSTRUCTION.

Cement Blocks.

Decorative Forms in Cement Block Construction. Louis H. Gibson. Gives suggestions for the artistic use of this material, recently coming into use. Ills. 2500 w. Munic Engng—Dec., 1905. No. 73755 C.

Chimneys.

Statical Computations for Chimneys (Zur Statischen Untersuchung von Schornsteinen). Franz Heckelbacher. A brief examination of the conditions of stability for masonry chimneys of round and square section; with a graphical diagram enabling the proportions to be scaled off directly. 2000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Nov. 25, 1905. No. 73872 D.

The Photobiography of a Chimney. Edgar Mels. Illustrated description of the second largest chimney in America, built at Newark, N. J. 800 w. Sci Am —Dec. 2, 1905. No. 73554.

Concrete.

Hair Cracks, Crazing and Map Cracks on Concrete Surfaces. Albert Moyer. Gives results of investigations made to determine the cause and the remedy. 1500 w. Eng Rec—Dec. 16, 1905. No. 73920.

Reducing the Voids in Broken Stone for Concrete by Mixing Different Sizes. E. J. McCaustland. Gives results of tests on mixtures of stones of various sizes. 700 w. Eng News—Dec. 7, 1905. No. 73626.

The Decoration of Concrete with Colored Clays. Henry C. Mercer. Read before the Assn. of Am. Port. Cem. Mfrs. Suggestions for the artistic treatment of concrete, with editorial. 2500 w. Eng News—Dec. 28, 1905. No. 74032.

Concrete Blocks.

The Waterproofing of Concrete Blocks and Walls. H. H. Rice. Discusses the causes of permeability and the remedies. Ills. 1500 w. Cement Age—Dec., 1905. No. 73711.

Dams.

Notes on Stresses in Masonry Dams. Max am Ende. A study of the distribution of compression and shearing stresses, deriving formulas for tracing the trajectories of the maximum tensile, compression, and shearing stresses in a masonry dam. 2800 w. Engng—Dec. 8, 1905. No. 73904 A.

The Changes at the New Croton Dam. Charles S. Gowen. An expression of the writer's views in regard to the necessity of removing the embankment section, at the south and replacing with an extension of the masonry section. Does not think the rock foundation of the core-wall was unsafe. Ills. 3500 w. Pro Am Soc of Civ Engrs—Dec., 1905. No. 74093 E.

The Roosevelt Irrigation Dam in Arizona. Information concerning this extensive engineering work, with illustrations showing the substantial character of the concrete work. 1000 w. Sci Am—Dec. 16, 1905. No. 73724.

Erection.

American Methods of Erecting Buildings. R. A. Denell. Considers constructive methods, especially in regard to the increase in rapidity of construction and economy. Ills. Discussion. 12000 w. Jour Roy Inst of Brit Archts—Nov. 25, 1905. No. 74037 D.

Fireproof.

A $3,000 Fireproof House. F. W. Fitzpatrick. Illustrates and describes pleasing dwellings of hollow tile fireproof construction. 2200 w. Ins Engng—Dec., 1905. No. 74068 C.

The Majestic Building. Illustrated description of a fireproof combination theater and office building in Chicago. 1800 w. Ins Engng—Dec., 1905. No. 74069 C.

Fire Protection.

Fire Protection Precautions at the Stuyvesant Docks. H. W. Parkhurst. An illustrated article explaining the changes that have been made and their object, in these terminal facilities of the Illinois Central at New Orleans. 3500 w. R R Gaz—Vol. XXXIX., No. 25. No. 74012.

The Safeguarding of Life in Theaters, A Study from the Standpoint of an Engineer. John R. Freeman. Presidential address before the A. S. M. E. A statement of present conditions, the problem presented and the solution, with a discussion of the subject generally. Also editorial. 15500 w. Ills. Eng News—Dec. 14, 1905. No. 73732.

Moving Buildings.

Moving a Block of City Residences. Describes the removal of two rows of city residences in Brooklyn, N. Y., of brick and stone construction of different styles, built at different periods. Ills. 1200 w. Eng Rec—Dec. 16, 1905. No. 73922.

Piles.

Improved System of Concrete Piling. The report of the Committee on Science and the Arts on the invention of Frank Shuman. 700 w. Ills. Jour Fr Inst—Dec., 1905. No. 73935 D.

Reinforced Concrete Pile Foundations for the Lattemann Building, Brooklvn, N. Y. Illustrates and describes the largest foundation work with reinforced concrete piles yet carried out in the United States. 1200 w. Eng News—Dec. 7, 1905. No. 73624.

The Simplex System of Concrete Piling. Constantine Shuman. An illustrated detailed description of this method of constructing foundations, the apparatus used and the process of producing a concrete pile. Also reviews the development, the uses, &c., and gives a general discussion. 7000 w. Pro Engrs' Club of Phila—Oct., 1905. No. 73937 D.

Reinforced Concrete.

Reinforced Concrete and Tile Construction in an Atlantic City Hotel. Illustrated detailed description of the construction of the annex of the Hotel Marlborough, built entirely of hollow tiles, combined with reinforced concrete and terra cotta, without any structural steel, brick or timber work. 3000 w. Eng Rec—Dec. 23, 1905. Serial. 1st part. No. 74018.

The Computations for T-shaped Floor Beams of Reinforced Concrete (Beitrag zur Berechnung der Plattenbalken von T-förmigen Querschnitte aus Eisenbeton). G. Ramisch. Deriving formulas for beams of T section, reinforced with round rods near the lower edge. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 17, 1905. No. 73821 D.

The Construction of a Reinforced Concrete Power House. Brief illustrated description of a building just completed for the Baltimore Electric Power Company. 1000 w. Sci Am Sup—Dec. 9, 1905. No. 73636.

The Economical Design of Reinforced Concrete Floor Systems for Fire-Resisting Structures. John S. Sewell. Aims to present simple and accurate formulas, with methods of applying them, to designs of mimimum cost, and to show the value of certain little used features of design, from a fire-resisting and economical point of view. 10400 w. Pro Am Soc of Civ Engrs—Dec., 1905. No. 74095 E.

See also Civil Engineering, Materials.

Roads.

Construction of the Benguet Road, Luzon, Philippine Islands. Illustrates and describes a notable piece of highway construction through rough country, and under exceptionally hard conditions. 2500 w. Eng Rec—Dec. 23, 1905. No. 74015.

Roofs.

Notes on the Concert Hall at Zürich (A Propos de la Halle des Concerts de Zurich). Prof. B. Recordon. Discussing especially the design of framed timber roofs of large span; the Zurich concert hall is covered by a braced arch of 50 metres clear span. 3500 w. 1 plate. Bull Tech de la Suisse Rom—Nov. 10, 1905. No. 73877 D.

The Catastrophe at Charing Cross. Editorial on the accident at Charing Cross Station, when two bays of the large roof collapsed without any apparent reason. 1200 w. Engng—Dec. 8, 1905. No. 73907 A.

Steelwork.

Steelwork of the Ash Plant of the New York Edison Co. Illustrated detailed description of this plant in New York, which contains 350 tons of structural steel. 1800 w. Eng Rec—Dec. 9, 1905. No. 73674.

Subways.

Mail Handling Facilities of the Chicago Freight Tunnels. Illustrates and describes the arrangements made, especially the construction of a tunnel to run under the post-office where the mails may be loaded and unloaded. 1000 w. R R Gaz—Vol. XXXIX., No. 25. No. 74014.

Rapid Transit Subway Construction on Fulton St., Brooklyn. An account of the change in plans to a four-track structure, with illustrated description of construction work. 2300 w. Eng Rec—Dec. 23, 1905. Serial. 1st part. No. 74016.

Tunnels.

Progress in the New Jersey Tunnels and Subways. Information concerning the tunnels connecting Jersey City and New York. Ills. 1500 w. Sci Am—Dec. 9, 1905. No. 73632.

The Crowning Work of the Simplon Tunnel. Drawings and engravings showing the means employed for the very difficult operation of constructing the passage through 40 m. of saturated decomposed clay slate. 1600 w. Engr, Lond—Dec. 8, 1905. No. 73911 A.

The Hudson River Tunnels. Brief accounts of three pairs of tunnels being extended under the Hudson River between New York and Jersey City. 1700 w. Ir Age—Dec. 7, 1905. No. 73580.

Tunnel Construction on Salt River Reclamation Project, Arizona. Beverly R. Harrison. Briefly describes some difficult tunnel work. Ills. 1200 w. Eng Rec—Dec. 16, 1905. No. 73919.

MATERIALS OF CONSTRUCTION.

Building Stone.

The Microscopic Structure of Building Stones. Henry Leffmann. Discusses the rocks and rock-substitutes used in engineering construction, and the relation between laboratory observation and practical application, indicating results that have been obtained. Also general discussion. 7000 w. Pro Engrs' Club of Phila—Oct., 1905. No. 73936 D.

Cement.

Experiments on the Manufacture of White Portland Cement. Charles Delavan Quick. Discusses the commercial practicability of producing a pure white Portland cement. 1800 w. Eng News—Dec. 28, 1905. No. 74033.

Portland Cement Materials. O. H. Howarth. Considers the importance of thorough mixing; the presence of iron; and the sources of materials in the United States. 4800 w. Mines & Min—Dec., 1905. No. 73716 C.

The First Attempt to Manufacture Natural Cement in the United States. Edwin C. Eckel. Gives a letter describing an attempt to manufacture this product, made by a Mr. Randolph, of Virginia, in 1817. 1000 w. Eng News—Dec. 7, 1905. No. 73630.

Explosives.

The Chemical Analysis of Dynamites. Graduation thesis by J. P. Benbrook, Jr., and J. H. Fulton. Introductory notes explaining the composition of modern explosives, especially dynamites, giving two methods of analysis. 2700 w. Stevens Ind—Oct., 1905. No. 73930 D.

The Testing of Explosives Used in Engineering. J. B. Porter. Illustrates and describes apparatus and methods used discussing especially closed explosion chambers, crusher gauges, and devices for miniature blasts, reporting recent tests. Ills. 2400 w. Can Soc of Civ Engrs—Nov. 30, 1905. (Ad. proof.) No. 74092 C.

Reinforced Concrete.

The Bursting Strength of Reinforced Concrete Pipes. Describes experiments made by the engineers of the U. S. Reclamation Service with great care, which indicated that such a system of construction is not satisfactory for pipes under considerable heads. Also editorial. 5500 w. Eng Rec—Dec. 9, 1905. No. 73675.

The Fire-Resisting Qualities of Reinforced Concrete. Capt. John Stephen Sewell. An engineer's views on the requirements of fireproof construction and the adaptability of reinforced concrete. Ills. 4000 w. Ins Engng—Dec., 1905. No. 74067 C.

See also Civil Engineering, Construction.

Steelwork.

Structural Steelwork. W. S. Smart. Abstract of a paper before the Midland Jun. Gas Engng. Assn. Discusses the materials, girders, roofs and roof-covering, columns, &c. 3500 w. Ir & Coal Trds Rev—Dec. 1, 1905. No. 73687 A.

MEASUREMENT.

Geodesy.

The Complementary Geodetic Triangulation of the Higher French Alps (Sur les Triangulations Géodesiques Complémentaires des Hautes Regions des Alpes Françaises). P. Helbronner. With a list of stations and altitudes, and a brief review of the field work. 1800 w. Comptes Rendus—Nov. 13, 1905. No. 73826 D.

Photogrammetry.

The Photographic Measurement of Ocean Waves (Photographische Messung der Meereswellen). W. Laas. A fully-illustrated description of the application of methods of photographic surveying to the measurement of sea waves, during a voyage to and from South America. Three articles. 8000 w. 3 plates. Zeitschr d Ver Deutscher Ing—Nov. 25, Dec. 2, 9, 1905. No. 73802 each D.

Prismoidal Formula.

A New Form of Procedure for Earth-Work Computations and a Slide Rule Therefor. C. W. Crockett. Explains the use of the prismoidal formula and the cases to which it is applicable, indicating the process that led to the general rule, and the circular slide rule prepared by the writer. 2800 w. Eng News—Dec. 21, 1805. No. 73978.

Surveying.

Corrections for Instrumental Errors in Topographical Surveying (Compensation des Erreurs Instrumentales dans les Opérations Topographiques). H. Naudin. A review of the various errors of theodolites, levels, and other geodetic instruments, with methods for calibration and correction. 5000 w. Revue Technique—Nov. 25, 1905. No. 73839 D.

Mineral Land Surveying. James Underhill. Presents methods used at the present time for the survey of mineral lands in the western part of the United States. 1700 w. Min Rept—Dec. 7, 1905. Serial. 1st part. No. 73662.

Note on a New Instrument for Surveying Deep Bore Holes. J. B. Porter. Briefly outlines the usual methods of surveying bore holes, and gives a description of an apparatus invented by Wm. Helme, of Johannesburg. 1500 w. Ills. Can Soc of Civ Engrs—Nov. 30, 1905. (Adv. proof.) No. 74090 C.

Surveys for New York State Road Improvements. C. W. Trumbull. Read at Cornell Univ. An account of the methods of carrying out the necessary preliminary work for the extensive improvement of public highways now in progress. 5500 w. Eng Rec—Dec. 9, 1905. No. 73672.

Theodolite.

Some Surveying Instruments. An illustrated description of a special theodolite, made by Mr. Coradi, of Zürich, and a tacheometer, invented by Herrn. Mayer, and Wiesmann, engineers on the Simplon Tunnel. 1700 w. Engr, Lond—Dec. 15, 1905. No. 74057 A.

Transit.

Specifications for an Engineer's Transit and Level. L. S. Smith. A discussion of the best type of transit for topographic work, the changes needed, &c. Also engineer's leveling instruments. Ills. 4200 w. Wis Engr—Dec., 1905. No. 73750 D.

Triangulation.

The Triangulation and Construction Survey for the Simplon Tunnel. Horace Andrews. A summary of the work involved in the triangulation and the construction-surveys. 3000 w. Eng News—Dec. 21, 1905. No. 73982.

Wind Pressure.

A Recording Device for Measuring Wind Pressure (Registrierender Winddruck-Messapparat). Rudolf Müller. The direct pressure exerted on a square plate is transmitted to a recording drum; the force being opposed by a counterweight. 2000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 9, 1905. No. 73874 D.

MUNICIPAL.

Asphalt Plant.

An Asphalt Plant for Walks and Crossings in Small Cities. H. B. R. Craig. Describes an asphalt plant operated by the city of Kingston, Ont.,. for the past twelve years. 1000 w. Can Soc of Civ Engrs—Dec. 14, 1905. (Adv. proof.) No. 74088 C.

Destructors.

Destructors and Their Bye-Products. F. L. Watson. Abstract of a paper read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Describes the means of feeding in use, systems of storing, the methods of taking of the gases of combustion, &c., and matters relating to the plant generally. 4000 w. Elect'n, Lond—Dec. 1, 1905. No. 73683 A.

Pavements.

Brick Paving. Discusses present day methods and the details that will insure good construction, materials, &c. 3000 w. Munic Jour & Engr—Dec., 1905. No. 73514 C.

Brick vs. Asphalt Pavements. An illustrated article showing cost of construction and repairs of the rival pavements in Syracuse, N. Y. 1000 w. Brick—Dec., 1905. No. 73579.

Sewage.

Sewage Disposal at Berlin, Ont. A sewage plant, comprising two septic tanks, two storage tanks, a pumping station, and 14 acres of intermittent sand filters, is illustrated and described. 2400 w. Eng Rec—Dec. 23, 1905. No. 74017.

Sewage Disposal for Mansions and Large Country Houses. A. S. Goodridge. Read before the Inst. of San. Engrs. Considers methods of disposal, advocating the natural or earth processes wherever it is possible to apply them. 4000 w. Dom Engng—Dec. 9, 1905. No. 73649.

The Bacterial Purification of Sewage. Albert Glyndon. Gives a brief description of the more important systems of sewage disposal now in use. Ills. 2500 w. Sci Am—Dec. 9, 1905. No. 73631.

Sewers.

American Sewer Design and Construction. John S. Hodgson. With special reference to the metropolitan main drainage works, of Boston, Mass. 7500 w. Munic Jour & Engr—Dec., 1905. No. 73513 C.

Difficult Sewer Construction in Minneapolis. Illustrations, and brief description of sewers of concrete construction laid through land which was formerly the bed of the Mississippi River, and later a public dump ground. 600 w. Eng Rec—Dec. 2, 1905. No. 73576.

Joint Trunk Sewer of Eleven New Jersey Municipalities. Gives statistics of construction and illustrated description of notable details of this great work. 1800 w. Munic Engng—Dec., 1905. No. 73756 C.

Sewer Construction in Brooklyn. Explains the complications that have made necessary a number of large relief sewers, and much reconstruction of the existing sewers. 1700 w. Ills. Eng Rec—Dec. 2, 1905. No. 73573.

WATER SUPPLY.

Amsterdam.

Notes on the Improved Water Supply Works for the Amsterdam District (Mededeeling betreffende de Werken ten Behoeve van de Drinkwatervoorziening in de Stelling van Amsterdam). R. P. van Royen. Describing the complete plant for a filtered supply of ground water. 15000 w. De Ingenieur—Nov. 11, 1905. No. 73880 D.

Filters.

The Reconstruction of the Poughkeepsie Water Filters. This was the first sand filter built in the United States. It has been completely reconstructed and covered and its new features are illustrated and described. 2800 w. Eng Rec—Dec. 2, 1905. No. 73569.

Reservoirs.

The Construction of a Reinforced Concrete Reservoir at Fort Meade, South Dakota. Samuel H. Lea. Gives a brief description of the locality, and the conditions requiring the construction, and the new pipe line, with details of the reservoir and its construction. Ills. 7400 w. Eng News—Dec. 28, 1905. No. 74031.

Springs.

Causes of the Diminution in the Flow of Springs (La Cause de l'Appauvrissement des Sources). M. Houllier. A review of observations made in the valley of the Somme, showing that intensive cultivation of the soil is abstracting an increasing proportion of moisture. 2500 w. Revue Technique—Nov. 25, 1905. No. 73840 D.

Treatment.

The Treatment of Water with Copper Sulphate at Denver, Colo. George T. Prince. Gives results of the treatment of a small lake at City Park, and also the treatment of Marston Lake reservoir. Ills. 500 w. Eng News—Nov. 30, 1905. No. 73550.

Wells.

Water Supply and the Driving of Wells. John Sanford. An illustrated article on this work in connection with the development of farm plumbing work. 3500 w. Met Work—Dec. 30, 1905. No. 74086.

WATERWAYS AND HARBORS.

Erosion.

The Coast Erosion and Sea Defences of North-Western Europe. Abstract of three articles by M. Bonnin, in *La Nature*, supplemented by observations. 1600 w. Engr, Lond—Dec. 1, 1905. No. 73696 A.

Locks.

Mechanical Lift Locks in America. Lieut-Col. Thomas W. Symons. Extracts from a paper submitted to the 10th Int. Nav. Cong. Describes the three kinds of mechanical locks suggested to accomplish the lift of 112 ft. at Cohoes, and the rather remarkable lock proposed for Lockport. 2000 w. Eng Rec—Dec. 16, 1905. No. 73921.

Panama.

Mr. Wallace Before the Panama Board. A statement of the recommendations of the former Chief Engineer of the Isthmian Canal. 1700 w. R R Gaz—Vol. XXXIX., No. 22. No. 73543.

The Conflict of Engineers Over Plans for the Panama Canal. Three papers by Mr. William Ham. Hall discussing the relative merits of the several different plans for the canal and explaining some of the reasons for the conflict of opinion among engineers. 7000 w. Eng News—Nov. 30, 1905. Serial. 1st part. No. 73549.

Paris.

The Port of Paris (Le Port de Paris). Pierre Jolibois. A detailed account of the growth of the port and its successive improvements since the beginning of the nineteenth century. 10000 w. Revue Technique—Oct. 25, 1905. No. 73834 D.

Pier.

Pier in Reinforced Concrete on the Guadalquivir, Spain (Embarcadero de

Hormigon Armado en el Guadalquivir). Juan Manuel de Zafra. Illustrated description of a pier constructed on the Hennebique system, with double track, and unloading derrick. 2000 w. 3 plates. Revista de Obras Publicas—Nov. 15, 1905. No. 73869 D.

River Improvement.

The Grand River, Ontario Peninsula. W. H. Breithaupt. Discusses the effects of deforestation and swamp drainage, and the need of river improvement. Ills. 2000 w. Can Soc of Civ Engrs—Dec. 14, 1905. (Adv. proof.) No. 74089 C.

Suez Canal.

The Clearing of the Suez Canal from Obstruction by a Dynamite Ship (Déblaiement du Canal de Suez Obstrué par un Navire Chargé de Dynamite). An illustrated account of the clearing of the Suez Canal from the wreck of the dynamite steamship Chatham. 2000 w. Génie Civil—Nov. 18, 1905. No. 73809 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Space Telegraphy.

Recent Advances in Wireless Telegraphy. J. Erskine-Murray. Abstract of a paper before the Glasgow Sec. of the Inst. of Elec. Engrs. Explains the Marconi untuned coherer system, the modern tuned systems, the more recent systems, the transmitters, limit of distance, &c. 5800 w. Elect'n, Lond—Dec. 15, 1905. No. 74049 A.

The Murgas System of Wireless Telegraphy. Joseph Murgas. Illustrated description of this invention for transmitting intelligence. The main object is to produce different spark frequencies from a source of current without the employment of interrupters. 1500 w. Elec Rev, N Y—Dec. 2, 1905. No. 73511.

The Production of Mechanical Effects by the Electric Current at a Distance (Production à Distance des Effects Mécaniques du Courant Electrique sans Fil de Ligne). C. D. Kubitzki. An illustrated description of the apparatus of Branly for controlling distant electrical devices by magnetic waves. 2000 w. Revue Technique—Oct. 25, 1905. No. 73833 D.

Tele-Photography.

Long Distance Electric Photography (Elektrische Fernphotographie). Dr. Arthur Korn. A review of the methods which have been proposed for the transmission of portraits and autographs by electricity, with a special account of the recent successful operation between Munich and Nuremberg. 3500 w. Elektrotech Zeitschr—Dec. 14, 1905. No. 73859 B.

DISTRIBUTION.

Cables.

Street Cable Systems. S. J. Watson. Abstract of a paper read before the Manchester Loc. Sec. of the Inst. of Elec. Engrs. and of the discussion. Discusses the design and arrangement of both the draw-in systems and the solid systems, cost of construction, &c. 4800 w. Elect'n, Lond—Dec. 8, 1905. No. 73902 A.

Conductors.

An Improved System of Arranging Electrical Conductors (Eine Neue Verlegungsart für Leitungen). Ernst Kuhlo. Describing an improved form of metallic tube and connections for underground electric conductors. 2500 w. Elektrotech Zeitschr—Dec. 7, 1905. No. 73858 B.

Twin Flexibles. Donald Smeaton Monro. Notes on the uses and frailties of flexible cord conductors. 1700 w. Elec Rev, Lond—Nov. 24, 1905. No. 73594 A.

Converters.

"Permutators." Charles V. Drysdale. Describing a special form of rotary converter, in which the exciting field is produced by the primary current in a short-circuited magnetic core, instead of using an external magnet. 2300 w. Elect'n, Lond—Dec. 8, 1905. No. 73901 A.

Detectors.

Ground Detectors and Their Connections. James T. Coe. Describes various types, with diagrams. 2500 w. Am Elect'n—Dec., 1905. No. 73568.

Fuses.

Notes on the Standardization of Fuses. Alfred Schwartz. Considers the particulars in connection with which standardization would be advantageous. 2400 w. Elec Rev, Lond—Dec. 1, 1905. No. 73680 A.

Notes on Continental Systems of Fuse Standardization. Alfred Schwartz. Gives the principal points in connection with fuses contained in the official regulations, with remarks. 2000 w. Elec Rev, Lond—Dec. 15, 1905. No. 74046 A.

House Service.

Electricity as a Home Comfort. J. D. Mackenzie. Considers some of the applications and discusses the design and the method of executing the work. 3000 w. Elec Engr, Lond—Dec. 15, 1905. Serial. 1st part. No. 74043 A.

Installation.

The Installation of Electric Equipment from a Fire Insurance Point of View. C. W. Rohrer. The proper installation, the testing of materials, and the hazards of defective wiring are discussed, and the importance of inspection. 1800 w. Cal Jour of Tech—Sept., 1905. No. 74078 C.

London.

London's Power Supply. T. H. Minshall. Information concerning the present supply of electrical energy, and the proposed schemes, the relative cost of production, &c. 1400 w. Elec Wld & Engr—Dec. 9, 1905. No. 73668.

Networks.

Computations for Equalization in Closed Networks (Die Ausgleichsrechnungen in Geschlossenen Leitungsnetzen). B. Soschinsky. A mathematical investigation based upon an improvement of the approximate method of Gauss. Two articles. 8000 w. Elektrotech Zeitschr—Nov. 23, 30, 1905. No. 73853 each B.

The Distribution of Pressure and Current Over Alternating-Current Circuits. A. E. Kennelly. Explains methods of computation. 3500 w. Harvard Engng Jour—Nov., 1905. Serial. 1st part. No. 73743 D.

Switches.

Improved Switch System for High Voltages in Mining Plants (Moderne Hochspannungs-Schaltanlagen für den Betrieb in Bergwerks-Anlagen). H. Mack. Especial attention is given to the prevention of ignition of mine gases; oil switches are described, and the general arrangement of underground installations. 1800 w. Elektrotech Zeitschr—Nov. 30, 1905. No. 73854 B.

Oil-Bath Switchgear. Leonard J. Pumphrey. Considers some of the points of a good oil for switch work. 1500 w. Elec Rev, Lond—Nov. 24, 1905. No. 73593 A.

ELECTRO-CHEMISTRY.

Accumulators.

A Novel Storage Battery. Dr. Alfred Gradenwitz. Describes a novel accumulator being brought out in Germany in which the two electrodes are made of lead and zinc peroxide. 1200 w. Am Elect'n—Dec., 1905. No. 73563.

Some Points Relating to Storage Batteries and Boosters. L. Brockman. Read before the Dublin Sec. of the Inst. of Elec. Engrs. Discusses features of present-day cells, their function and management, and various types of boosters and the work for which each is suited. 7000 w. Elec Engr, Lond—Dec. 15, 1905. No. 74045 A.

The Chemical Composition of the Nickel Oxide Electrode in the Jungner-Edison Accumulator (Ueber die Chemische Zusammensetzung der Nickeloxyd-Elektrode im Jungner-Edison-Akkumulator). Julian Zedner. An examination of the chemical nature of the active material in the Edison storage battery. 2000 w. Zeitschr f Elektrochemie—Nov. 17, 1905. No. 73867 G.

The Edison Iron-Nickel Accumulator. M. U. Schoop. Translated from the *Elektrotechnische Zeitschrift*. An illustrated article giving data and test results of a cell experimented with by the writer. 7700 w. Sci Am Sup—Dec. 23, 1905. Serial. 1st part. No. 73989.

Electric Furnaces.

Electrically-Heated Carbon-Tube Furnaces. Abstract of a paper by R. S. Hutton and W. H. Patterson before the Faraday Soc. Deals with electric furnaces constructed with a carbon tube through which an electric current is passed. Ills. 1400 w. Elec-Chem & Met Ind—Dec., 1905. No. 73723 C.

Electrolysis.

The Theory of Electrolytic Dissociation (Versuch einer Theorie der Elektrolytischen Dissociation). R. Malmström. A mathematical examination of the theory of Jahn and Nernst upon the weakening of a strong electrolyte by dissociation taking into account the electrical energy of the ions. 5000 w. Zeitschrift f Elektrochemie—Nov. 17, 1905. No. 73866 G.

Hypochlorites.

Some Observations Respecting the Relation of Stability to Electro-Chemical Efficiency in Hypochlorite Production. W. Pollard Digby, before the Faraday Soc. Reports results of tests which show that no test of the efficiency of any apparatus for the electrolytic productions of the hypochlorites can be regarded as complete without an estimation of losses through instability, and a mention of the volume of the contents of the electrolyzing tank. 1800 w. Elec Engr, Lond—Nov. 24, 1905. No. 73591 A.

Review.

The Progress of Electrochemistry in the Past 25 Years (Progrès de l'Electrochimie dans ces Derniers 25 Ans). C. D. Koubitzki. A review of the results following the work of Arrhenius, and the development of the theory of ions. 3000 w. Revue Technique—Nov. 10, 1905. No. 73837 D.

ELECTRO-PHYSICS.

Commutation.

Commutation Theory. A. Press. Mathematical discussion leading to working rules for preventing sparking at brushes. 800 w. Elec Wld & Engr—Dec. 16, 1905. No. 73923.

Notes on Commutation and Pole-Changing (Einiges über Kommutation und Wendepole). E. Arnold. A review of the discussions of Müller and of Pichelmayer, deriving formulas for computing the effects of commutation. 3000 w. Zeitschr f Elektrotechnik—Nov. 26, 1905. No. 73862 B.

Condensers.

High Tension Electric Condensers (Les Condensateurs Electriques à Haute Tension). A. Schoenenberger. Describing the Moscicki condensers, made of glass tubes coated with electrically deposited silver. 2000 w. Bull Tech de la Suisse Rom—Nov. 10, 1905. No. 73878 D.

Definitions.

Voltage Voltage-Difference, Potential Potential-Difference, Electromotive Force (Spannung, Spannungsdifferenz, Potential, Potentialdifferenz, Elektromotorische Kraft). Fritz Emde. A mathematical examination of electric potential relations, deriving critical definitions in accordance with the notation of the vector analysis. 4000 w. Zeitschr f Elektrotechnik—Dec. 10, 1905. No. 73865 B.

Electromagnets.

Easy Method of Approximating Magnet Windings. Charles R. Underhill. Describes a graphic system, giving charts and citing actual cases to facilitate following the methods employed. 900 w. Am Elect'n—Dec., 1905. No. 73565.

Test of a Valve Magnet. C. P. Nachod. Gives a test on a magnet, showing the effect which the position of the magnetizing coil with respect to the working air-gap has on the pull produced. 400 w. Elec Wld & Engr—Dec. 23, 1905. No. 74029.

The Approximate Calculation of Plunger Electromagnets. Charles R. Underhill. Shows graphically the relation between pull, area, ampere-turns, and length of air-gap, or stroke of plunger, with mathematical explanation. 400 w. Elec Wld & Engr—Dec. 16, 1905. No. 73925.

Induction.

Standards of Mutual Induction. G. F. C. Searle, and J. R. Airey. Explains the method of calculating the coefficient of mutual induction to any desired degree of accuracy, when the secondary coil lies inside the primary coil. 3500 w. Elect'n, Lond—Dec. 8, 1905. No. 73903 A.

Interrupters.

A Study of Interrupters (Sur les Eclateurs). R. de Valbreuze. A general review of the development of modern interrupters, with especial reference to the production of Hertzian waves for space telegraphy. 10000 w. Bull Soc Int d Electriciens—Nov., 1905. No. 73868 F.

GENERATING STATIONS.

Accumulators.

See Electrical Engineering, Electrochemistry.

Alternators.

The Dick Kerr Alternator for Steam Turbine Drive. Illustrated description of a new alternator for steam-turbine speeds. 900 w. Elect'n, Lond—Nov. 24, 1905. No. 73595 A.

The Influence of Armature Reaction upon the Wave Form of Alternators (Der Einfluss der Ankerrückwirkung auf die Wellenform von Wechselstrommaschinen). Dr. G. Benischke. A study of the causes of variation of wave forms from the true sine curve. 3000 w. Zeitschr f Elektrotechnik—Nov. 19, 1905. No. 73861 B.

Armatures.

Finding Faults in a Direct Current Armature. Adolph Shane, in *The Iowa Engineer.* Explains methods of especial interest for small plants. 1000 w. Engr, U S A—Dec. 1, 1905. No. 73617 C.

Winding of Direct-Current Armatures. A. C. Jordan. A detailed description of the various operations performed by an armature winder. Ills. 2500 w. Elec Jour—Dec., 1905. No. 74074.

Berlin.

Machinery for the Extension of the Berlin Electricity Works (Maschinenanlagen zur Erweiterung der Berliner Elektrizitätswerke). Illustrating two new generating sets of 6,500 h. p. each, the triple-expansion engines by Sulzer and by the Görlitz works, with A. E. G. alternators. 1800 w. 3 plates. Zeitschr d Ver Deutscher Ing—Dec. 9, 1905. No. 73807 D.

Hydro-Electric.

Construction of Canadian Niagara Power Company's 100,000-Horse-Power Hydroelectric Plant at Niagara Falls, Ontario. Cecil B. Smith. Abstract of a paper read before the Canadian Soc. of Civ Engrs. Describes the construction work, buildings, machinery, &c. 5000 w. Elec Rev, N Y—Dec. 2, 1905. No. 73512.

Hydraulic Station at Cusset, near Lyons, France. F. M. Bryan. An illustrated description of one of the largest hydraulic plants in France, which utilizes the power of the Rhone for operating lamps and motors in the city of Lyons. 3000 w. Elec Wld & Engr—Dec. 9, 1905. No. 73665.

Hydro-Electric Development at Garvins Falls, Bow, N. H. Edward B. Richardson. A detailed description of the station equipment. The plant will have a total capacity of 3,950 kw. 2800 w. Jour Assn of Engng Socs—Oct., 1905. No 73749 C.

Hydro-Electric Development in Italy. L. Ramakers. Illustrated detailed description of the 36,000 volt transmission plant at Montereale-Cellina. 2000 w. Am Elect'n—Dec., 1905. No. 73564.

Hydro-Electric Power Under the Highest Head in New England. Illustrated detailed description of the interesting plant of the Chittenden Power Co., near Rutland, Vt. 4000 w. Elec Wld & Engr—Dec. 2, 1905. No. 73612.

The Chatel St. Denis Station (Usine de Chatel-St.-Denis). K. A. Breuer. A fully illustrated description of one of the power houses of the Freybourg district in Switzerland. Serial. Part I. 2000 w. 1 plate. Bull Tech de la Suisse Rom—Nov. 25, 1905. No. 73879 D.

The Garvins Falls Dam, Canal and Hydro-Electric Plant, Bow, N. H. George G. Shedd. An illustrated description of the power development at this point on the Merrimac River, about four miles below Concord, N. H. 3500 w. Jour Assn of Engng Soc's—Oct., 1905. No. 73748 C.

The Hydraulic Works of the Chittenden Power Co., Rutland. An illustrated description of a plant which will furnish electricity for street railway, light and power purposes at Rutland, Vt. 3000 w. Eng Rec—Dec. 9, 1905. No. 73673.

The Hydro-Electric Power Plant of the Brembo River. Dr. Alfred Gradenwitz. Illustrates and describes this recently completed plant in northern Italy. 1200 w. Sci Am Sup—Dec. 30, 1905. No. 74062.

The Hydro-Electric Station at Champ. A. Steens. Illustrated description of a power plant built to furnish electricity for motive power in various industrial establishments in the vicinity of the Fure and Morge valleys. Contains an important reinforced-concrete conduit. 2000 w. Eng Rec—Dec. 9, 1905. No. 73671.

The Trinity River Plant of the North Mountain Power Company. Brief illustrated description of an interesting power transmission system of the Pacific Coast, and some of the difficulties of its construction. 1200 w. R R Gaz—Vol. XXXIX., No. 26. No. 74085.

Isolated Plant.

An Electric Power Plant in the West Indies. Percival Robert Moses. A general description of an isolated plant in a plantation, with tabulated records of performance, and details of operative costs. 3500 w. Engineering Magazine—Jan., 1906. No. 73896 B.

Power Plant of a Large Cotton Mill. W. H. Smead. Illustrates and describes an interesting electrical power plant at Charlotte, N. C., for operating cotton mills. 1300 w. Engr, U S A—Dec. 15, 1905. No. 73787 C.

The Mechanical Plant of the Tietz Warehouse in Munich (Die Technischen Einrichtungen des Warenhauses Hermann Tietz in München). Julius Weil. Describing the plant of a large department store. Four 200 h. p. Diesel motors are coupled direct to dynamos for power and lighting. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 25, 1905. No. 73803 D.

London.

A New Electric Power Scheme for London. Outlines the scheme of the Additional Electric Power Supply (London) Bill, discussing its main points. 3300 w. Engng—Nov. 24, 1905. No. 73603 A.

Bow Electric Generating Station. W. H. Patchell. Abstract of a paper read before the Inst. of Elec. Engrs. illustrating and describing the station and its equipment. 2500 w. Mech Engr—Dec. 16, 1905. Serial. 1st part. No. 74042 A.

New York.

The New Waterside Station of the New York Edison Company. Fully illustrated detailed description of this large station on the East river water-front, Manhattan, New York. 1300 w. Power—Dec., 1905. No. 73699 C.

Switzerland.

Electric Plant of the City of Thun, Switzerland. B. F. Hirschauer. Illustrates and describes this plant which is operated by hydraulic power, obtained from the river Aar. 2500 w. Elec Rev, N Y—Dec. 23, 1905. No. 73992.

See also Civil Engineering, Construction.

LIGHTING.

Balancers.

Regulation and Compounding of Lighting Balancers. Budd Frankenfield. Gives methods for determining the regulation or the compounding. 2800 w. Elec Wld & Engr—Dec. 23, 1905. No. 74026.

Churches.

The Lighting of Churches and Libraries. E. Leavenworth Elliott. Discusses the illumination of both gothic and churches of the amphitheater type and of libraries, giving suggestions. Ills. 2500 w. Cent Sta—Dec., 1905. No. 73655.

Streets.

Street Lighting. Haydn T. Harrison. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Considers the factors of importance in judging the degree of illumination in streets, and the means of comparing accurately, based on the measurement of the minimum illumination. 3300 w. Elect'n, Lond—Dec. 15, 1905. Serial. 1st part. No. 74048 A.

Strong Currents.

A Method for Measuring Heavy Currents (Strommesser für Hohe Stromstärken). Dr. Eugen Nesper. The current is measured by the manner in which it affects iron filings in proximity to a permanent magnet. 1200 w. Elektrotech Zeitschr—Nov. 30, 1905. No. 73855 B.

Train Lighting.

See Railway Engineering, Motive Power and Equipment.

MEASUREMENT.

High Frequency.

The Measurement of High-Frequency Currents and Electric Waves. Abstract of a Cantor lecture by Prof. J. A. Fleming on recent progress in quantitative measurements. Ills. 3500 w. Engng—Dec. 1, 1905. No. 73690 A.

Losses.

The Measurement of Iron Losses in Asynchronous Polyphase Motors (Messung und Berechnung der Eisenverluste in den Asynchronen Drehstrommotoren). J. Bache-Wig and O. S. Bragstad. Describing the construction of curves for the determination of hysteresis and eddy-current losses. 2000 w. Zeitschr f Elektrotechnik—Dec. 3, 1905. No. 73864 B.

The Separation of Iron and Friction Losses in Direct Current Machinery. F. Handley Page. Principally describes a modification of the Kapp method showing results obtained. 900 w. Elec Rev, Lond—Dec. 1, 1905. No. 73681 A.

Meters.

An Efficiency Meter for Electric Incandescent Lamps. Edward P. Hyde and H. B. Brooks. Describes the theory and operation of an instrument designed and constructed to meet the need of an efficiency meter in the photometric work of the Bureau of Standards. Also editorial. 5200 w. Elec Wld & Engr—Dec. 2, 1905. No. 73613.

An Induction Meter for Alternating Currents (Induktionszähler für Wechselstrom). A report of the Reichsanstalt upon an alternating-current meter of the Siemens-Schuckert Company for currents from 5 to 300 amperes and pressures up to 600 volts; with details of construction. 1500 w. Elektrotech Zeitschr—Dec. 14, 1905. No. 73860 B.

Photometry.

The Theory and Practice of the Spherical Photometer (Das Kugelphotometer in Theorie und Praxis). Dr. L. Bloch. A full description of the Ulbricht photometer for the direct measurement of the mean spherical intensity of a source of light, with examples of its application. Two articles. 10000 w. Elektrotech Zeitschr—Nov. 16, 23, 1905. No. 73851 each B.

Testing.

Testing Electrical Machinery. An editorial explaining the methods used, especially the Hopkinson test, the Swinburne test, and the method devised by Dr. Charles V. Drysdale. 1400 w. Elec Rev, N Y—Dec. 9, 1905. No. 73640.

The Commercial Testing of Small Motors up to 15 B. H. P. Read before the Newcastle Sec. of Inst. of Elec. Engrs. Explains the tests usually made on motors of this size, and describes the apparatus used. 4500 w. Elec Engr, Lond—Dec. 15, 1905. Serial. 1st part. No. 74044 A.

The Testing of Electric Generators and Motors. Dr. Charles V. Drysdale. An illustrated explanation of the methods of testing and the construction of the testing plant. 4800 w. Engng—Nov. 24, 1905. No. 73599 A.

MOTORS.

Induction Motors.

Core Losses in Induction Motors. R. E. Hellmund. Gives a method for determining the core losses for motors with phase-wound secondaries. 400 w. Elec Wld & Engr—Dec. 23, 1905. No. 74028.

Induction Motor Characteristics by the Vector Diagram. H. C. Specht. Gives a practical example of the use of the vector diagram in working up the characteristics of an induction motor. 1000 w. Elec Jour—Dec., 1905. No. 74075.

The Practical Application of the Heyland Diagram for Induction Motors. W. C. Way. Gives description of the use of the "circle diagram" in design of induction motors, with figures and tables. 1500 w. Elec Wld & Engr—Dec. 23, 1905. No. 74027.

Motor Design.

Design of a Battery Motor. Clarence W. Coleman. Illustrates and describes a motor designed by the writer for operating railroad semaphore signals, though capable of application to other uses. 2000 w. Am Elect'n—Dec., 1905. No. 73566.

Railway Motors.

A 75 Horse Power Continuous Current Railway Motor for High Voltages (Ein 75 P. S. Gleichstrom Bahnmotor für Hochspannung). H. Rikli-Kehlstadt. Details of windings for a continuous-current motor to be operated at 1,500 volts; with curves and tables of its performance. 2000 w. Schweiz Bauzeitung—Nov. 25, 1905. No. 73871 B.

Shunt-Wound Tramway Motors. A. Johnston. Some points on the working of shunt-wound motors, especially in tramway service. 2200 w. Elec Engr, Lond—Dec. 1, 1905. No. 73679 A.

Single Phase.

The Arrangement of Windings in Single-Phase Motors (Die Zerlegung der Amperewindungen des Einphasenmotors). Adolf Thomälen. A general study of the theory of the single-phase motor, with analytical and graphical investigation of the windings of rotor and stator. Two articles. 12000 w. Elektrotech Zeitschr—Dec. 7, 14, 1905. No. 73856 each B.

TRANSMISSION.

Analogy.

Belt Transmission of Power as an Analogue of Electric Transmission. Byron B. Brackett. Develops an analogy between the electric transmission and the belt drive. Also editorial. 3500 w. Elec Wld & Engr—Dec. 9, 1905. No. 73666.

Arresters.

Protective Apparatus. N. J. Neall. Illustrates and describes the principal forms of arresters used on the Continent. 1200 w. Elec Jour—Dec., 1905. No. 74076.

Circuits.

Transmission Circuit. Charles F. Scott. An elementary consideration of self-induction, regulation and mutual induction. The first of a series of articles treating generally of induction and capacity in electric circuits. 4500 w. Elec Jour—Dec., 1905. No. 74072.

Earth.

Use of the Earth in High-Tension Transmissions. Emile Guarini. An account of the results obtained by M. Thury and the French commission of electricians, with remarks. 1600 w. Sci Am Sup—Dec. 30, 1905. No. 74063.

South Africa.

The Electrical Transmission of Power from the Victoria Falls to the Rand. Prof. W. E. Ayrton. From *The Times* Engng. Sup. Gives the writer's views in regard to this scheme, and compares them with the views of Mr. Wilson Fox. 2000 w. Mech Engr—Nov. 25, 1905. No. 73587 A.

The Zambesi Power Scheme. W. B. Esson. Discusses the scheme proposed by H. Wilson Fox. 1700 w. Elec Rev, Lond—Dec. 15, 1905. No. 74047 A.

Surging.

Oscillographic Researches on Surging in High Tension Lines. C. David. Abstracted, with introduction by L. A. Herdt. Deals with the subject of surges on transmission lines, giving the results of experiments. Ills. 2200 w. Can Soc of Civ Engrs—Nov. 2, 1905. No. 73744 D.

Temperature Effects.

Temperature Effects in Spans. C. P. Nachod. Showing the relation between the sag and tension in a span where there is a temperature variation. 700 w. Elec Wld & Engr—Dec. 7, 1905. No. 73667.

Vermont.

Electric Transmission and Distribution in Vermont. An illustrated description of the hydro-electric generating station and sub-stations of the Chittenden Power Company at Rutland. 1500 w. Am Elect'n—Dec., 1905. No. 73561.

MISCELLANY.

Addresses.

Dr. W. M. Thornton's Inaugural Address to the Newcastle Section of the Institution of Electrical Engineers. Abstract. Discusses the science and art of engineering, the education of an engineer, &c. 2500 w. Elect'n, Lond—Nov. 24, 1905. No. 73598 A.

Mr. J. M. Munro's Inaugural Address to the Glasgow Section of the Institution of Electrical Engineers. (Abridged.) Historical review of early work and of electricity in civic service. 6000 w. Elect'n, Lond—Nov. 24, 1905. No. 73596 A.

S. L. Pearce's Inaugural Address to the Manchester Section of the Institution of Electrical Engineers. (Abridged.) A general survey of the year's work, noting advances made, and the problems yet unsolved. 8000 w. Elect'n, Lond—Nov. 24, 1905. No. 73597 A.

INDUSTRIAL ECONOMY

Contracts.

Government Contracts; Legal Pitfalls and How to Avoid Them. George A. King and William B. King. Gives the rules of importance in guiding contractors entering into contracts with the United States, in the present number. 3500 w. Eng Rec—Dec. 16, 1905. Serial. 1st part. No. 73917.

Co-operation.

Useful Co-operation. W. C. Kerr. Read at meeting of the district managers of the Westinghouse Electric & Mfg. Co. Considers the essentials of co-operation and the things that make it difficult. 4000 w. Elec Jour—Dec., 1905. No. 74073.

Education.

Factory Education. O. M. Becker. An introductory article discussing the education of factory operatives. 2500 w. Mach, N Y—Dec., 1905. Serial. 1st part. No. 73527 C.

Laboratory Courses in Engineering Schools. Prof. D. S. Jacobus. Quotes from paper by Prof. Charles E. Lucke, before the A. S. M. E., and gives the discussion presented by the writer, which describes the work at Stevens Inst. 5000 w. Stevens Ind—Oct., 1905. No. 73929 D.

Teaching Agricultural Engineering in Land Grant Colleges. C. J. Zintheo. Shows the need of a complete course of agricultural engineering and what it should include, comparing the United States, with European countries, to the former's disadvantage. Especially discusses the need of instruction in the use and care of farm machinery. 2500 w. Eng News—Dec. 21, 1905. No. 73980.

Germany.

The American and the German Peril. Louis J. Magee. A comparison of American and German industrial methods, with especial emphasis upon the value of the interchange of experiences. 4000 w. Engineering Magazine—Jan., 1906. No. 73890 B.

Inventions.

The Real Want and Commercial Value of Potential Inventions. F. C. Fraentzel. Statements bearing on inventions as an investment and the real want and commercial value of patented inventions to both the inventor and investor, based on an experience of twenty years in obtaining letters-patent. 2500 w. Stevens Ind —Oct., 1905. No. 73927 D.

Iron Industry.

A Review of Conditions in the American Iron Industry. Edwin C. Eckel. A critical review of the statistics of iron manufacture in the United States during 1903, 1904, and 1905, with tables and diagrams. 3500 w. Engineering Magazine —Jan., 1906. No. 73892 B.

Iron Ore.

The Lake Superior Iron Ore Trade in 1905. Dwight E. Woodbridge. A report of the most prosperous year yet recorded, the production exceeding the previous year by more than 6,000,000 tons. 4000 w. Ir Age—Dec. 28, 1905. No. 74024.

Labor.

The Fight for the Open Shop. Isaac F. Marcosson. An account of the victory of organized employers over labor unions, and the protection of non-union men. Ills. 5000 w. World's Work—Dec., 1905. No. 73736 C.

Manufacturing.

The Engineer in Manufacturing Industries. Walter S. Graffam. Explains what is meant by manufacturing industries, and the position which the engineer holds in relation to manufacturing. 3000 w. Elec Rev, N Y—Dec. 9, 1905. No. 73641.

Mineral Industry.

The Relation of the Federal Government to the Mining Industry. C. N. Hays. Read at the El Paso meeting of the Am. Min. Cong. Endeavors to show what the federal government is now doing for this industry, and the directions in which it may safely expand its activities. 5000 w. Min Rept—Nov. 30, 1905. No. 73508.

Patents.

Some Phases of Our Patent System. W. R. Wood. Explains some points in the application for patents, and the reasons for them. 2200 w. Am Mach—Vol. 28, No. 49. No. 73648.

Water Transportation.

Water Transportation; Its Economic Importance. Frank Haigh Dixon. Discusses the economic importance of water transportation in the United States at the present time, under the heads of ocean, lake, river, and canal transportation. 10500 w. St Louis Ry Club—Nov. 10, 1905. No. 73758.

Works Management.

The Square Deal in Works Management. O. M. Becker. The first instalment of a serial; the present portion discussing the common-sense of the management of men. 3500 w. Engineering Magazine—Jan., 1906. No. 73894 B.

MARINE AND NAVAL ENGINEERING

Battleship.

U. S. Battleship Virginia. C. A. Gardiner. Description of the vessel, armament, machinery, &c. 5500 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73954 H.

Boilers.

See Mech. Engng., Steam Engineering.

Capstan.

New Electric Capstan at Antwerp. Illustrated description. 800 w. Sci Am—Dec. 30, 1905. No. 74060.

Central Plant.

Mechanical Plant of the New 23d St. Ferry Terminals, New York. Describes the central power plant and heating system that will serve the new terminals of the Lackawanna, the Erie, and the Central Railroad of New Jersey. Ills. 3500 w. Eng Rec—Dec. 2, 1905. No. 73572.

Electrical Devices.

Electricity in Service on British Battleships. Edward Nelson. An illustrated description of the electrical apparatus found on one of the British cruisers which recently visited New York. 2000 w. Elec, N Y--Dec. 6, 1905. No. 73546.

Floating Docks.

The Influence of Admission and Discharge of Water upon the Stability of Floating Docks (Ueber die Verminderung der Stabilität der Schwimmdocks durch die in denselben Vorhandenen Wasser-Ein-bezw.-Austrittsöffnungen). Alexander Dietzius. With diagrams showing the effect of various degrees of immersion upon the stability. 4000 w. Schiffbau—Nov. 22, 1905. No. 73870 D.

Gunboats.

Contract Trials of the U. S. Gunboat Paducah. A report of the standardization trials, and the performance on the preliminary trial. 1000 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73952 H.

Japan.

The Japanese Navy After the War. A report of the splendid results, with illustrations of the Russian warships refloated and captured. 2200 w. Sci Am—Dec. 16, 1905. No. 73727.

Landing Stage.

The Landing Stage at Lome. Illustrated description of this landing stage on the coast of the Gulf of Guinea, constructed by the German Government. 1700 w. Engr, Lond—Nov. 24, 1905. No. 73608 A.

Launches.

Problems in Connection with High-Speed Launches. Clinton H. Crane. Discusses the shape of the under water form; the skimming idea, and other points in design. Ills. 1500 w. Rudder—Dec., 1905. No. 73578 C.

Lifeboats.

The Evolution of the Lifeboat. Capt. C. H. M'Lellan. A review of the development of the lifeboat, dating back to 1785, with illustrations. 2000 w. Marine Engng—Jan., 1906. No. 74020 C.

Liners.

The Construction of a Great Liner. A half-dozen illustrations showing clearly a great ocean steamship in the earlier stages of construction, with comments. 800 w. Engr, Lond—Dec. 8, 1905. No. 73908 A.

The Launch of the Empress of Britain. Illustrated description of a fine vessel that is to be placed in service between Britain and Canada. 2200 w. Marine Engng—Jan., 1906. No. 74022 C.

The New Hamburg-American Liner Amerika. An illustrated detailed description of this large and luxurious steamer recently put in service. 1200 w. Marine Engng—Dec., 1905. No. 73515 C.

Machinery Weights.

Weights of Machinery. W. F. Sicard. A discussion of machinery weights in relation to shipbuilding, limited to what is commonly included in the term. 9200 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73950 H.

Motor Boats.

A Suction Gas Plant Boat. From *Zeit. d. Ver. Deut. Ing.* Illustrates and describes the boat Lotte, used in the carrying trade between Cologne, Antwerp, and Rotterdam. 800 w. Engr, Lond—Dec. 1, 1905. No. 73693 A.

The Power Boat in 1905. W. P. Stephens. A review of the year, and the progress in the field of design. Ills. 3800 w. Rudder—Dec., 1905. No. 73577 C.

Naval Training.

The New Scheme of Training Naval Officers. A short account of the training given in the Royal Naval College, at Osborne; and abstracts from a recent "Statement of Admiralty Policy," referring principally to the training of engineer officers for the Navy. 6500 w. Engr, Lond—Dec. 8, 1905. No. 73912 A.

Paddlewheel.

A Motor Paddlewheel for Small Boats. Translated from *La Vie Automobile.* Illustrates and describes a new stern wheel for propelling motor boats, recently experimented with in the Seine. 700 w. Sci Am Sup—Dec. 2, 1905. No. 73559.

Ship Construction.

Pneumatic Tools as Applied to Ship Construction. C. Schofield. Abstract of a paper read before the N.-E. Coast Inst. of Engrs. & Shipbuilders. An explanation of the methods adopted in the American shipyards as to the application of pneumatic tools in ship construction. Ills. 2500 w. Mech Engr—Dec. 9, 1905. No. 73799 A.

Shipyards.

Tershana—A Turkish Shipyard. An interesting description, showing the worthlessness of the yard, the financial condition, &c. 1300 w. Engr, Lond—Dec. 8, 1905. No. 73910 A.

South Africa.

The Ports of South Africa—Cape Town and Durban. Reviews the history of harbor construction on the coast of South Africa, and describes the recent improvements. Map. 3000 w. Engng—Dec. 8, 1905. No. 73905 A.

Speed Recorder.

New Electrical Speed Recorder. H. C. Dinger. An illustrated description of the Monitor Speed Recorder, which aims to indicate accurately the rate of speed of a vessel. 4500 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73953 H.

Torpedo.

The New Bliss-Leavitt Torpedo. S. D. V. Burr. Brief descriptions of the Howell torpedo, and the Russian torpedo, with illustrated detailed description of the Bliss-Leavitt torpedo. 2200 w. Ir Age—Dec. 14, 1905. No. 73720.

Torpedo Boats.

Thornycroft 120-Horse-Power Gasoline-Propelled Torpedo Launch. Brief illustrated description. 600 w. Sci Am—Dec. 30, 1905. No. 74061.

Torpedo Boat No. 20, Goldsborough. G. H. Thayer. Detailed description, with report of official trial performance. 5000 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73948 H.

Turbine Steamers.

Recent Turbine Steamers. Illustrations and short descriptions of the Manxman, Princesse Elisabeth, Mahenó, and a new vessel for King Edward VII. 2400 w. Marine Engng—Dec., 1905. No. 73516 C.

The Turbines of the "Carmania." Illustration of this new steamship, with description of the turbine machinery. 1500 w. Sci Am—Dec. 23, 1905. No. 73985.

The New Turbine Liner Carmania. An illustrated description of the largest turbine steamer yet constructed. 4000 w. Marine Engng—Jan., 1906. No. 74019 C.

Triple-Screw Turbine-Driven Cunard Liner "Carmania." A fully illustrated detailed description of this large vessel for service on the Atlantic, with report of trials. 15000 w. Engng—Dec. 1, 1905. No. 73688 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air-Cooled.

A 100-H. P. Two-Cycle Air-Cooled Motor. Illustrated description of a motor built for a western railroad which is the largest of this type built in the United States. 2000 w. Automobile—Dec. 7, 1905. No. 73637.

Automobile Lessons.

Elementary Lessons on Motor Cars. K. D'Esterre-Hughes. The first of a series of six lectures which R. Sedgwick Currie gave before the Ladies' Automobile Club of Great Britain and Ireland. The subject of the present lecture is "The Engine." 2500 w. Autocar—Dec. 9, 1905. Serial. 1st part. No. 73796 A.

Cleveland.

Cleveland 30-35 Horse-Power Model F. Illustrated detailed description. 1200 w. Automobile—Dec. 28, 1905. No. 74082.

Construction.

Automobile Construction. F. C. Mason. The first of a series of articles which will give an illustrated description of a light gasolene touring car, and also a runabout which will be cheap and easy to build. 600 w. Am Mach—Vol. 28, No. 51. Serial. 1st part. No. 73977.

Converting Apparatus.

Apparatus for Charging Storage Batteries. Illustrates and describes a device, especially suited to automobile battery charging, based on the discovery that the vapor given off by mercury when heated will provide a path for the passage of current in one direction only. 2000 w. Automobile—Dec. 14, 1905. No. 73761.

Daimlers.

English Daimlers for American Market. An illustrated description of the main features of these cars, which differ somewhat from the English form. 2000 w. Automobile—Nov. 30, 1905. No. 73506.

De Dietrich.

The New 12-15-H. P. De Dietrich Car. Illustrated detailed description of the new chassis, the engine, &c. 800 w. Auto Jour—Nov. 25, 1905. Serial. 1st part. No. 73584 A.

Engines.

Automobile Engines Considered from the Operative Point of View. Rodolphe Mathot. A scientific discussion of the design of the internal-combustion engine for the automobile, based on fundamental principles. 4000 w. Engineering Magazine—Jan., 1906. No. 73895 B.

Exhibition.

Motor Car Exhibition at Olympia. An illustrated review of this exhibition, its striking features, and more interesting exhibits. 3800 w. Engr, Lond—Nov. 24, 1905. Serial. 1st part. No. 73605 A.

The Olympia Exhibition. A general account of this very successful automobile exhibition, with illustrations of many of the exhibits, and comments on the progress. 4500 w. Auto Jour—Nov. 25, 1905. No. 73582 A.

Industrial Vehicles.

Electric Vehicles for Semi-Public Service. Illustrated description of express wagons equipped with trolley pole and special electric motor, for using current from the over-head feed wires of street railway companies. 1300 w. Automobile—Dec. 14, 1905. No. 73760.

Knox.

Knox Air-Cooled Motor-in-Front Car. Illustrated description of a new high-powered touring car with a vertical air-cooled motor in front, known as Model G. 1600 w. Automobile—Dec. 28, 1905. No. 74081.

Lamps.

New Ideas in French Lamps. Illustrates and describes the Besnard lamp and projector, and the Bleriot lamp burning gasoline and oxygen. 1000 w. Automobile—Nov. 30, 1905. No. 73505.

Omnibuses.

Gaso-Electric Equipment for Fifth Avenue Bus. Illustrates and describes the motive power equipment of this thirty-passenger vehicle. 1500 w. St Ry Jour—Dec. 2, 1905. No. 73520 C.

Motor Omnibuses at the Olympia Exhibition. An illustrated review of the exhibits, showing recent progress. 4500 w. Tram & Ry Wld—Dec. 7, 1905. No. 73973 B.

The "S 41" Type Petrol Omnibus. Illustrates and describes a type notable for the manner in which the engine may be used as a brake. 1200 w. Auto Jour—Dec. 9, 1905. No. 73797 A.

Runabout.

Reo Runabout with Folding Rear Seat. Illustrated description of an 8-horsepower American light car. 1500 w. Automobile—Dec. 14, 1905. No. 73763.

Siddeley.

The Siddeley 32-Horse-Power Motor-Car. Illustrated description of the châssis and mechanism of this car which was exhibited at Olympia. 3500 w. Engng—Dec. 8, 1905. No. 73906 A.

Thomas.

Thomas 50-Horsepower Flyer for 1906. An illustrated article describing the detail changes in designing the 1906 car. 1700 w. Automobile—Dec. 21, 1905. No. 73998.

Touring Car.

New Columbia 28 H. P. Touring Car. Illustrated description of a new gasoline car to be known as Mark XLVI. Notes its interesting features. 2000 w. Automobile—Dec. 14, 1905. No. 73762.

Winton.

The 1906 Winton Cars. Begins an illustrated description of these cars in which the vertical type of engine has been adopted. 900 w. Auto Jour—Nov. 25, 1905. Serial. 1st part. No. 73583 A.

COMBUSTION MOTORS.

Automobile Engines.

See Mechanical Engng., Automobiles.

Diagram.

A New Work Diagram for Gases. Frank Foster. Describes a diagram devised to illustrate the actions of, and simplify the calculations for gas turbines, turbo compressors, gas engines, air compressors, and hot air engines. 2000 w. Engr, Lond—Dec. 1, 1905. No. 73694 A.

Gasoline Motor.

Alterno-Rotative Gasoline Motor. Illustrated description of the new Primat motor. The movement is produced by a set of pistons working alternately in a circular chamber, and the to-and-fro action is transformed to a rotary movement by means of a crank. 900 w. Sci Am Sup—Dec. 2, 1905. No. 73560.

Gas Power.

Electric Power from Blast Furnace Gas. H. Freyn. From a paper read before the W. Soc. of Engrs. Notes the quantity of gas used for the various purposes of the blast furnace plant, showing that a little less than 50 per cent. is available for use outside the plant. Discusses the cost of the electric power station and installation, operation, &c. 4000 w. Ir Age—Dec. 28, 1905. No. 74025.

The Use of Gas for Power and Heating. Ernest A. Dowson. Abstract of a paper read at the Birmingham Assn. of Mech. Engrs. Considers the advantages of gas-engines and plant, describing the properties and manufacture of gases which are economical for industrial use, in the present number. 4000 w. Sci Am Sup—Dec. 9, 1905. Serial. 1st part. No. 73635.

Gas Producers.

Reversed-Combustion Gas Producers (Gazogènes à Combustion Renversée). J. Deschamps. A review of the work of the late M. Lencauchez, with especial reference to the reversed draft producer for generating fuel gas. 7500 w. Mem Soc Ing Civ de France—Oct., 1905. No. 73881 G.

The Gas Producer for Heating Processes. William B. Chapman. Describes the American gas producer and gives some of the applications made of it with marked economy and advantage. 2000 w. Sci Am—Dec. 23, 1905. No. 73983.

The Suction Type of Gas Producer. Abstract of a paper by C. H. Treglown, read before the S. Staffordshire and Warwickshire Inst. of Min. Engrs. Describes the Tangye suction gas plant, discussing factors affecting the working and the advantages. 3000 w. Col Guard—Dec. 15, 1905. No. 74052 A.

Packing.

An Improved Method of Packing the Cylinder Head of a Gasoline Engine. From the *English Mechanic and World of Science.* Directions for successful packing are given. 700 w. Sci Am Sup —Dec. 2, 1905. No. 73556.

Suction Gas.

A Successful Suction Gas Producer Central Station Plant. An illustrated description of a plant at Newton, N. J., which furnishes current for lighting and power for a town of 5,000 inhabitants. 2000 w. Power—Dec., 1905. No. 73710 C.

Suction-Gas Producers. Prof. A. Humboldt Sexton. Illustrates and describes four forms of suction gas producers, explaining the principles on which suction producers are based. 3800 w. Mech Engr —Dec. 9, 1905. No. 73798 A.

The Davey-Paxman Suction-Gas Plant and Gas Engine. Illustrated detailed description. 2200 w. Engng—Nov. 24, 1905. No. 73600 A.

The Thompson-Burger Gas Producer and Engine. Illustrated description of this automatic cut-off gas engine and the suction gas producer. 2000 w. Ir Age—Dec. 21, 1905. No. 73940.

Testing.

Study of a Gasoline Engine Test. P. F. Walker. Describes investigations made by students for graduating theses, stating the object of the tests, describing apparatus and methods used, and discussing results. Ills. 4500 w. Engr, U S A —Dec. 15, 1905. No. 73788 C.

Testing High Power Modern Gas Engines. William H. Spiller. Read before the Tech. Soc. of Kansas City, Mo. An account of the severe test in the factory which the modern gas engine has to undergo. 1300 w. Min Wld—Dec. 23, 1905. No. 74006.

Turbines.

The Gas Turbine (Les Turbines à Gaz). A. Berthier. A general description of the present status of the gas turbine question, with reference to the turbines of Stolze and of Armengaud and Lemale. 2500 w. Génie Civil—Dec. 2, 1905. No. 73814 D.

HEATING AND COOLING.

Boilers.

Elements of Commercial Value in Household Boilers. J. M. W. Kitchen. Discusses the desirable requirements in a household water or steam heater. 2000 w. Met Work—Dec. 9, 1905. No. 73611.

Heat Units.

The Heat Unit and Its Application to the Heating of Buildings. George G. Bennett. Read before the Ohio Soc. of Mech., Elec., and Steam Engrs. Gives method of finding the loss of heat units, illustrating by example. 800 w. Engr, U S A—Dec. 1, 1905. No. 73620 C.

Refrigeration.

Pipe Line Refrigeration. J. E. Starr. Address before the Am. Soc. of Refrig. Engrs. Reviews the work done in pipe line distribution, both those using brine circulation and those using direct expansion, the problems in connection with such systems and the progress made in solving them. 2500 w. Eng News—Dec. 14, 1905. No. 73734.

1,000 Horse Power Refrigerating Machine (1,000 Pferdige Kältemaschine). G. Döring. A description of the Boyle machine at the Quincy Market cold storage warehouse in Boston. 1800 w. Zeitschr d Ver Deutscher Ing—Dec. 2, 1905. No. 73806 D.

Train Heating.

See Railway Engineering, Motive Power and Equipment.

HYDRAULICS.

Flow.

The Gaging of Streams by Chemical Means. W. L. Butcher. Brief remarks on the usefulness of this method and how to carry it out, also suggesting a method of using aniline dyes. 1100 w. Eng News—Dec. 14, 1905. No. 73733.

Governors.

The Speed Regulation of Turbines (Die Geschwindigkeitsregulierung der Turbinen). A. Budau. A review of the improvements which have been made during the past thirty years, with especial reference to Continental practice. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 17, 1905. No. 73820 D.

Plumbing.

Plumbing in the Butterick Building, New York. Illustrated detailed description of the water supply and drainage system in a large mercantile and office building. 2000 w. Met Work—Dec. 9, 1905. No. 73610.

Pumping.

Pumping Engines and Pumping Machinery. Oscar F. Rabbe. Read before the Ohio Soc. of Mech., Elec., & Steam Engrs. Discussing some of the sources of trouble, the data that should be included in specifications, &c. 1500 w. Engr, U S A—Dec. 1, 1905. No. 73619 C.

Turbine Plants.

Foreign and American Hydraulic and Turbine Plants. Frank C. Perkins. Gives illustrations and brief descriptions of plants showing the arrangement of horizontal shaft turbines, and vertical shaft turbines, and the types of governors employed. 1700 w. Engr, U S A—Dec. 1, 1905. No. 73615 C.

Turbines.

Hydraulic Turbines (Turbines Hydrauliques). M. Abraham. A general examination of the various types of turbine watch wheels, with a mathematical discussion of the mechanical principles involved in turbine design. Serial. Part I. 3000 w. Revue Technique—Oct. 25, 1905. No. 73832 D.

The Distribution of Pressure in the Francis Turbine, and the Pressure on the Step (Die Druckverhältnisse in der Francis Turbine und der Druck auf den Spurzapfen). Karl Kobes. A mathematical investigation of the action of the water-pressure in turbines of the Francis type, with especial reference to the load on the spindle step. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 8, 1905. No. 73825 D.

Water Power.

Water-Power Plants; Common Troubles, Causes, and Remedies. W. E. Crane. A brief discussion of early plants, of shape of dams, and the remedies for various troubles. Ills. 1700 w. Power—Dec., 1905. No. 73700 C.

MACHINE WORKS AND FOUNDRIES.

Arsenal.

The United States Arsenal at Frankford. F. A. Stanley. Begins an illustrated detailed description of this arsenal, at Philadelphia, its equipment and manufactures. 2300 w. Am Mach—Vol. 28, No. 50. Serial. 1st part. No 73765.

Bearings.

Experimental Determination of the Relative Value of Short Bearings. Reports some experiments made by H. E. Hayward for the Link Belt Engng. Co. which show that, under the conditions of chain links, the usual assumption is not correct. Ills. 1000 w. Am Mach—Vol. 28, No. 52. No. 74035.

Boring Mill.

A New Bullard Boring Mill. Illustrated description of a new 54-inch rapid production boring and turning mill, noting its features of interest. 1500 w. Ir Age—Nov. 30, 1905. No. 73517.

Cams.

The Double Cam System of the Monotype. Illustrated detailed description of the system used and the cam-cutting machine. 2000 w. Am Mach—Vol. 28, No. 50. No. 73766.

Castings.

Casting Non-Ferrous Metals. From *Eisen Zeitung*. Suggestions for successful work in the casting of bronze, brass, copper, and various alloys. 1000 w. Mech Engr—Nov. 25, 1905. No. 73589 A.

Open Hearth Steel Castings. W. M. Carr. The first of a series of articles treating of the important points of their manufacture by the acid and by the basic open hearth processes. 3000 w. Foundry—Dec., 1905. Serial. 1st part. No. 73944.

Steel Castings and the Constitution of Steel. Percy Longmuir. Discusses the effect of various constituents and methods on the structure and qualities. Ills. 1500 w. Ir Trd Rev—Nov. 30, 1905. No. 73503.

Strength of Hydraulic Press Castings. Frank B. Kleinhans. Describes the work of forming steel plates into various shapes by the hydraulic press. Diagrams. 700 w. Ir Trd Rev—Nov. 30, 1905. No. 73504.

Why Castings Curve. From the *English Mechanic and World of Science*. Discusses the causes and remedies. Ills. 2500 w. Sci Am Sup—Dec. 16, 1905. No. 73729.

Dies.

Folding or Bending Dies. Carroll Ashley. Illustrates and describes dies which will not stretch or distort the metal. 1000 w. Am Mach—Vol. 28, No. 49. No. 73646.

Drawing Office.

The Organization of a Drawing Office. W. O. Horsnaill. Describes a system applicable to drawing-offices dealing with all kinds of engineering work. Ills. 2500 w. Engr, Lond—Dec. 1, 1905. Serial. 1st part. No. 73692 A.

Drawings.

The Reproduction of Drawings of Great Length or Number. L. F. Rondinella. A review of the methods for making long prints, giving illustrated descriptions of several continuous-printing machines and their working. Also general discussion. 5800 w. Pro Engrs' Club of Phila—Oct., 1905. No. 73938 D.

Electric Driving.

The Applications of Electricity in the Royal Gun Factory, Woolwich Arsenal. Col. H. C. L. Holden. Read before the Inst. of Elec. Engrs. Illustrates and describes applications of electricity and the methods, some of which are a departure from ordinary practice. 3000 w. Elec Engrs, Lond—Nov. 24, 1905. Serial. 1st part. No. 73592 A.

Facings.

Foundry Facings. W. G. Scott. Read before the A. F. A. Convention. Describes the different grades of material, and gives a suitable method for testing the quality. 4500 w. Foundry—Dec., 1905. No. 73946.

Foundry.

Tendencies in the Foundry Industry. Dr. Richard Moldenke. Read before the New England Foundrymen's Assn. Considers the tendency toward multiple operations, sand treatment, standardizing, steel scrap, ferro alloys, the electric furnace, and the direct metal process. 3800 w. Ir Age—Dec. 21, 1905. No. 73941.

Forgings.

The Manufacture of Forgings. Frank Somers. Read before the Staffordshire Iron & Steel Inst. A review of the tools used to save human labor in the manufacture of iron forgings from the earliest invention to the present. 2500 w. Ir & St Trds Jour—Dec. 16, 1905. No. 73990 A.

Jigs.

Two V-Block Drill Jigs. A. B. Christman. Sketches and description of jigs for drilling holes in ¼-inch rolled shafting are given, and the method of correctly locating the drill bushings is also described. 700 w. Am Mach—Vol. 28, No. 49. No. 73647.

Joints.

Designing of Riveted Joints. Charles E. Frick. Some suggestions helpful in designing joints and testing their efficiency. 1500 w. Boiler Maker—Dec., 1905. No. 73638.

Lathes.

Lathes for the Amateur. From the *English Mechanic and World of Science.* Considers the principal points to be settled in buying a lathe. Ills. 4000 w. Sci Am Sup—Dec. 9, 1905. No. 73634.

Machine Design.

Design and the Safety of Machinery. Edward Crowe. Abstract of a paper read before the Cleveland Inst. of Engrs. and of the discussion. Considers the influence of design on the strength and safety. 2500 w. Ir & Coal Trds Rev—Dec. 15, 1905. No. 74059 A.

Molding.

Modern Molding Machines (Moderne Formmaschinen). H. Baur. A very fully illustrated account of the development of the modern moulding machine, with especial reference to German practice. Two articles. 5000 w. Stahl u Eisen—Nov. 15, 1905. No. 73848 each D.

Molding Machine Practice. F. W. Hall, in *The Patternmaker.* Illustrates and describes work that required the getting up of a special device. 1500 w. Foundry—Dec., 1905. No. 73945.

Molding Materials in the Foundry. E. L. Rhead. Considers the points of importance in selecting suitable materials for making molds. 3000 w. Mech Engr—Nov. 25, 1905. No. 73586 A.

Patterns.

The Care of Patterns. Robert Grimshaw. Considers the classification and storage of foundry patterns, their designation, marking, and care. 2400 w. Ir Age—Dec. 21, 1905. No. 73943.

Records.

Mechanical Department Records—The Graphic System. L. A. Larsen. Presents the merits of the graphic system, explaining its use. 2000 w. Am Engr & R R Jour—Dec., 1905. No. 73532 C.

Saw.

The Toothless Cold Saw. E. D. Sewall. Gives an experience in repairing a cross cut saw of very hard plate, with comments by Prof. Benjamin Silliman of Yale College, experiments, and applications of the method. 3000 w. Ir Age—Dec. 21, 1905. No. 73942.

Shops.

The Works of the F. Wesel Manufacturing Company. Illustrated description of interesting works where machines and tools used by electrotypers and stereotypers, and by printers and photo-engravers are made. The individual motor drive is employed throughout. Some of the methods are also described. 2200 w. Am Mach—Vol. 28, No. 51. No. 73976.

Thermit.

Thermit Practice in America. E. Stütz. An account of the progress made within the past eighteen months, in the introduction in the United States of the Thermit process as applied in various engineering and mechanical arts. Ills. 5000 w. Jour Fr Inst—Oct., 1905. No. 73934 D.

Tools.

Tools for Machining Segments. Edward Snyder. Illustrates and describes tools and methods used. 2000 w. Am Mach—Vol. 28, No. 52. No. 74036.

Turret Machine.

The Prentice Multiple Spindle Automatic Turret-Machine. Illustrates and describes a machine for boring, turning, drilling, reaming, and threading small castings, forgings or pieces that have been finished on one end in a rod machine and require operation on the reverse end. 1200 w. Ir Age—Nov. 30, 1905. No. 73518.

Welding.

Autogenous Welding (La Soudure Autogène). Report of the Laboratory of the Conservatoire des Arts et Métiers upon the oxy-acetylene blowpipe for welding plates and structural members of iron and steel. 3000 w. Revue Technique—Nov. 25, 1905. No. 73838 D.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Alloys.

Iron-Nickel-Manganese-Carbon Alloys. Abstract of the seventh report to the Alloys Research Committee on the properties of these alloys, by Dr. H. C. H. Carpenter, R. A. Hadfield and Percy Longmuir. 2500 w. Engr, Lond—Nov. 24, 1905. No. 73607 A.

Seventh Report to the Alloys Research Committee: On the Properties of a Series of Iron-Nickel-Manganese-Carbon Alloys. Dr. H. C. H. Carpenter, R. A. Hadfield, and Percy Longmuir. An account of the investigations made and results obtained. Ills. 22000 w. Inst Mech Engrs—Nov. 17, 1905. No. 73747 D.

The Equilibrium Diagram of the Iron-Carbon Alloys (Sur le Diagramme d'Equilibre des Alliages Fer-Carbone). Georges Charpy. A study of the cooling curves of the iron-carbon alloys, with a view to determine the law of cooling. 1800 w. Comptes Rendus—Dec. 4, 1905. No. 73831 D.

Amalgams.

Amalgams: Their Composition, Properties, Preparation, and Uses. From the French of Leon de Mortillet. Discusses the general properties of amalgams and applications made of them. 3500 w. Sci Am Sup—Dec. 23, 1905. No. 73986.

Boiler Materials.

Materials for Boilers. J. Rowland Brown. Read before the Ohio Soc. of Mech., Elec., and Steam Engrs. An examination of specifications of materials of boilers and their requirements. 6000 w. Engr, U S A—Dec. 1, 1905. No. 73618 C.

Chromium.

The Use of Ammonium Persulfate in the Determination of Chromium in Steel. Harry E. Walters. Gives an outline of method used by the writer, applicable for ordinary chrome steel, but not for tungsten or molybdenum steels. 1000 w. Pro Engrs' Soc of W Penn—Dec., 1905. No. 74065 D.

Lubricants.

Friction, Lubricants and Lubrication. Stanley H. Moore. Discusses these subjects in detail. 3000 w. Power—Dec., 1905. No. 73708 C.

Oils and Oiling. H. R. Carter. The various kinds of oil are discussed and their value as lubricants, illustrating instruments used in testing them. 2400 w. Prac Engr—Dec. 15, 1905. Serial. 1st part. No. 74040 A.

Shear.

Behavior of Materials of Construction Under Pure Shear. E. G. Izod. A report of experimental tests made of the better known and commercially used materials. 3300 w. Ills. Inst of Mech Engrs—Dec. 15, 1905. No. 74064 D.

MEASUREMENT.

Dynamometer.

A Dynamometric Brake for the Measurement of the Power of Motors (Sur un Frein Dynamometrique Destiné à la Mesure de la Puissance de Moteurs). A. Krebs. Describing a form of electric brake permitting the utilization of the greater portion of the power developed. 1500 w. Comptes Rendus—Nov. 13, 1905. No. 73827 D.

Inertia.

The Determination of the Moment of Inertia of Revolving Bodies (Bestimmung der Trägheitsmomente von Umdrehungsgungskörpern). Sigmund Wellisch. A graphical and analytical study, with practical applications to bodies of various forms. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 24, 1905. No. 73823 D.

Measuring Machine.

Recent Improvements in the Newall Measuring Machine. Illustrates and describes the new features recently introduced and the increase in size, the latest machine having a capacity of six feet. 900 w. Am Mach—Vol. 28, No. 48. No. 73539.

Pitot Tube.

Experiments with the Pitot Tube in Measuring the Velocities of Gases in Pipes. R. Burnham. A report of experimental investigations, describing the method used and presenting the results obtained as showing the practical accuracy of which the Pitot tube is capable. 2500 w. Eng News—Dec. 21, 1905. No. 73981.

Testing Machine.

A 600,000-Pound Screw-Testing Machine. Illustrated detailed description of a fine machine recently completed for the University of Illinois. 1000 w. Am Mach —Vol. 28, No. 51. No. 73975.

Thermometers.

Thermometers, Pyrometers, and Thermo-Regulators Operated by the Pressure of Saturated Vapors. Illustrates and describes apparatus of various types for exact determination of temperature. 4000 w. Sci Am Sup—Dec. 16, 1905. No. 73731.

POWER AND TRANSMISSION.

Ball Bearings.

The Hoffmann Manufacturing Co.'s Patent Ball Bearings and Steel Balls. An illustrated description of the construction and application of their patent ball bearings. 1500 w. Prac Engr—Dec. 1, 1905. No. 73677 A.

Bearings.

Bearings. A topical discussion. 3300 w. Pro Engrs' Soc of W Penn—Dec., 1905. No. 74066 D.

Coal Handling.

Coal Handling Plant at the Hoboken Terminal of the Lackawanna R. R. Illustrates and describes the two McMyler car dumping machines installed and their operation. 2800 w. Eng Rec—Dec. 9, 1905. No. 73670.

Compressed Air.

A Central Compressed Air Power Plant for Heavy Railroad Construction. Lucius I. Wightman. Illustrates and describes the plant for carrying out the heavy work on the low-grade freight line of the P. R. R. near Safe Harbor, Pa. 2500 w. Compressed Air—Nov., 1905. No. 73735.

Air Power in the Union Pacific Shops at Omaha, Neb. Illustrates and describes some of the applications of compressed air. 1000 w. Mod Mach—Dec., 1905. No. 73698.

Cone-Pulley.

Cone-Pulley Design. John Edgar. Gives as simple a method as possible ror so designing cone-pulleys that their ratios shall advance in geometrical progression. 1400 w. Am Mach—Vol. 28, No. 50. No. 73767.

Cranes.

The Wharf Cranes of the Pennsylvania Railroad Company at Greenville, N. J. John Lyle Harrington. Illustrations, with detailed description of cranes for handling freight, both bulk and package, between the railway cars and the vessels. 3000 w. Can Soc of Civ Engrs—Nov. 16, 1905. No. 73746 D.

Electric Driving.

A Discussion of the Various Systems of Electric Motor Driving. E. Kilburn Scott. Briefly considers belt driving, spur gearing, special cam gearing, worm gearing, chains, and friction gearing. Ills. 2400 w. Ir & Coal Trds Rev—Dec. 8, 1905. No. 73915 A.

Elevators.

A Special Air Lift for Printing Press Service. A. W. Cochran. Illustrated description of an air-lift for supplying paper to a newspaper press, in Portland, Ore. 1000 w. Eng News—Dec. 7, 1905. No. 73629.

Tests of Elevator Plant in the Trinity Building, New York. Illustrates and describes the elevator system installed in this 20-story building, giving a report of the tests made. 2500 w. Eng Rec—Dec. 16, 1905. No. 73918.

Hoisting.

A Study of Hoisting Machinery (Etude sur les Appareils de Levage). L. Rousselet. A general study of cranes and other mechanical hoisting devices; the first instalment discusses electric traveling cranes. Serial. Part I. 2000 w. Revue Technique—Nov. 10, 1905. No. 73835 D.

Prime Movers.

Prime Movers for Generators. W. H. Wakeman. An illustrated article calling attention to prime movers available for this purpose. Elec, N Y—Dec. 27, 1905. Serial. 1st part. No. 74008.

Speed-Changing.

Gear-Box Drives. H. T. Millar. Illustrates and describes several gear-box arrangements, some remarkable for the large number of changes obtainable, and others for the small number of gears in motion. 1100 w. Am Mach—Vol. 28, No. 50. No. 73768.

Unloaders.

Electrically Operated Ore Unloaders. Frank C. Perkins. An illustrated description of the labor saving devices used at the docks of the steel companies on the Great Lakes. 1600 w. Min Rept—Dec. 7, 1905. No. 73664.

Worm Drive.

The "Globoid" Worm Drive. Robert Grimshaw. Illustrated description of a new drive which has won success in Germany, for which is claimed 90 per cent. of useful effect. 400 w. Mach N Y—Dec., 1905. No. 73528 C.

STEAM ENGINEERING.

Adiabatic.

The Meaning of Adiabatic. Aims to show that three meanings are given to the word "adiabatic," and that this both confuses and misleads. 3000 w. Engr, Lond —Dec. 15, 1905. No. 74053 A.

Air Pumps.

Air Pumps for Marine Engines (Luftpumpen für Schiffmaschinen). C. Strebel. A general study of air-pump design, with numerous examples of modern types, both connected to the engine and independently driven. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 2, 1905. No. 72805 D.

Boiler-House.

Boiler-House Economy. A. W. Bennis. Abstract of a paper before the Engng. Soc., Huddersfield. Discusses points that require attention to prevent losses. 2800 w. Ir & Coal Trds Rev—Dec. 8. 1905. No. 73914 A.

Boiler Power.

Boiler Power for Lighting and Power Plants. Charles L. Hubbard. Gives a method of estimating quickly the boiler power required for heating, lighting or power purposes, giving results of sufficient accuracy for all practical purposes. 2000 w. Am Elect'n—Dec., 1905. No. 73567.

Boilers.

Blowing Down Boilers. W. H. Wakeman. An illustrated article considering neglected points in the care and operation of boilers. 2000 w. Power—Dec., 1905. No. 73706 C.

Boiler Inspection and Explosions. A. S. Atkinson. On some of the methods of inspection used by the steam boiler insurance companies. 2200 w. Boiler Maker—Dec., 1905. No. 73639.

Care, Use, and Design of Locomotive Boilers. Two papers, by George Austin, and by J. J. Malone, discussed together. 10400 w. Pro Pacific C Ry Club—Dec. 16, 1905. No. 73970 C.

Notes on the Performance of the Thornycroft Boiler in a Monitor. W. T. Cluverius. An account of the performance of the boilers of the harbor-defence monitor Arkansas. 1500 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73949 H.

Specification for Horizontal Tubular Boiler and Boiler-Room Equipment. Charles L. Hubbard. Gives a "dummy" useful in making up specifications for tubular boilers and their settings. 4500 w. Power—Dec., 1905. No. 73702 C.

The Care of Boilers. M. E. Wells. A discussion of the causes of leaks in boilers and the remedies. Ills. General discussion. 18000 w. Pro W Ry Club—Nov. 21, 1905. No. 73969 C.

The du Temple Water-Tube Boiler (Les Generateurs à Tubes d'Eau Système du Temple). H. Lassaux. Describing the general design of the du Temple small-tube boiler, with tabulated tests on French and Russian torpedo boats. 3500 w. Revue Technique—Nov. 10, 1905. No. 73836 D.

Boiler Tests.

Hydraulic Tests. William H. Fowler. Describes these tests for boilers and other vessels subject to steam pressure, giving hints for conducting them, and the information obtained. 1600 w. Mech Engr—Dec. 2, 1905. No. 73678 A.

Cylinders.

Calculating the Size of the Cylinders for a Multiple Expansion Engine. George Elfers. Illustrates, by example, the manner of solving this problem. 1700 w. Marine Engng—Jan., 1906. No. 74023 C.

Diagrams.

The Construction of Steam Diagrams (Konstruktion der Dampfdiagramme). Hr. Debye. An application of the investigations of Gütermuth upon the flow of steam through ports, to the study of the velocity of steam flow upon indicator diagrams. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 25, 1905. No. 73804 D.

Engines.

A Notable Mesta Corliss Engine. Illustrated detailed description of the 44 and 72 x 60 inch horizontal-vertical Corliss compound engine built for the Tennessee Coal, Iron & R. R. Co. 2000 w. Ir Age—Dec. 21, 1905. No. 73939.

Machinery at the New Royal Naval College, Dartmouth. Illustrates and describes a triple-expansion engine, with independent surface condenser, air and circulating pumps, and all necessary tanks, pipes, &c., installed for the purpose of instructing young officers in the practical working of the steam engine. 1000 w. Engr, Lond—Dec. 15, 1905. No. 74054 A.

Six-Cylinder Compound Engine (Machine à Vapeur Compound à Six Cylindres). An illustrated description of a rolling-mill reversing engine of 10,000 h. p. at the Cockerill works at Seraing, Belgium. 1500 w. 1 plate. Génie Civil—Nov. 25, 1905. No. 73812 D.

Exposition.

Steam Boilers and Engines at the Görlitz Industrial Exposition (Die Dampfkessel und Dampfmaschinen auf der Niederschlesischen Gewerbe und Industrie Ausstellung Görlitz 1905). Dr. Förster. An illustrated review, describing water-tube boilers, steam fittings, and engines of recent German design. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Nov. 18, 1905. No. 73800 D.

Flanges.

High-Pressure Steam-Pipe Flanges. Franz Koester. Comments and description of types. Ills. 1700 w. Power—Dec., 1905. No. 73705 C.

Fuels.

Coal-Dust Firing. Eustace Carey. Abstract of a paper read at Liverpool before the Soc. of Chem. Ind. Reports the results that have been obtained with coal-dust firing, and the advantages. 1800 w. Eng & Min Jour—Dec. 16, 1905. No. 73773.

Comparative Heat-Producing Values of Different Fuels. Prof. Erasmus Haworth. Explains the method usually adopted for testing heat-producing qualities and gives results and general information. 3800 w. Pro Age—Dec. 15, 1905. No. 73759.

Crude Oil Burning. J. R. Collins. Points on the requirements for the successful use of this fuel. Ills. 800 w. Engr, U S A—Dec. 15, 1905. No. 73789 C.

Fuel Substitutes. Prof. Arthur Lakes. Some of the different materials utilized for burning in regions where ordinary fuels are unattainable are discussed. Ills. 1400 w. Mines & Min—Dec., 1905. No. 73713 C.

The Utilization of Low Grade Fuels for Steam Generation. W. Francis Goodrich. The second and concluding paper deals with the adaptations of the boiler furnace and appliances to the satisfactory combustion of low-grade fuels. 3000 w. Engineering Magazine—Jan., 1905. No. 73893 B.

Governor.

The Tolli Spring Governor. Emile Guarini. Illustration with description of the operation of these governors. 800 w. Sci Am Sup—Dec. 2, 1905. No. 73557.

History.

The First Steam Engines out of England (Die Ersten Dampfmaschinen ausserhalb Englands). Conrad Matschoss. A review of early installations of Newcomen and Savery engines on the Continent, from 1715 to 1763, with illustration of a Newcomen engine built by Potter for the Königsberg coal mine in Hungary, in 1722. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 9, 1905. No. 73808 D.

Lubrication.

Steam Engine Lubrication. R. T. Strohm. Illustrates and describes the construction and operation of various lubricators, as applied to the steam engine, with the exception of those used in cylinder lubrication. 3000 w. Am Elect'n—Dec., 1905. No. 73562.

Pipe Coverings.

Value of Non-Conducting Coverings. William H. Fowler. Discusses the loss of heat which takes place in uncovered steam pipes, and the saving effected by non-conducting coverings. 1800 w. Mech Engr—Nov. 25, 1905. No. 73585 A.

Pressure.

Equalized Pressures. An explanation of the laws governing expansion and compression of gases, with diagrams. 1000 w. Ry & Loc Engng—Dec., 1905. No. 73526 C.

Smoke.

Conference of Smoke Abatement. Explains the objects and work of the Coal Smoke Abatement Society, and reviews the work of the conference held at Westminster. 7000 w. Engr, Lond—Dec. 15, 1905. No. 74056 A.

Steam Consumption.

The Steam Consumption of Piston Engines. T. Stevens and H. M. Hobart. Gives a table of the steam consumption of 33 piston-engines, with report of tests made. 1000 w. Power—Dec., 1905. No. 73704 C.

Steam Meter.

A Meter for Measuring the Flow of Steam (Dampfgeschwindigkeitsmesser). Describing the improved Gehre meter for measuring the velocity of steam in a pipe by taking the pressure on both sides of a contracted neck. 1500 w. Glückauf—Dec. 9, 1905. No. 73843 D.

Stokers.

Test of Shell Boilers Using the Roney Stoker. G. W. Baird. Report of a test made on the boilers of the Post-Office Department at Washington, D. C., to determine whether pea coal would furnish sufficient steam, its economic efficiency, and the quantity needed for a yearly supply. 900 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73951 H.

Superheating.

Properties of Superheated Steam. Prof. J. E. Denton. Reviews the results of investigations made by experimenters and the theories advanced and formulas deduced. 4000 w. Stevens Ind—Oct., 1905. No. 73926 D.

Superheated Steam and the Construction of Superheaters as Used in Power Plants. Franz Koester. Illustrations of types of superheaters, with a discussion of the use of superheated steam. 3500 w. St Ry Rev—Dec. 15, 1905. No. 73778 C.

Turbines.

A Broader Field for the Steam Turbine. Discusses the uses of the direct-connected continuous current turbine units. 1000 w. Eng News—Nov. 30, 1905. No. 73548.

Dimensions of Steam Turbines for Marine Work. E. M. Speakman. Read before the Inst. of Engrs. & Shipbuilders in Scotland. Discusses the steps necessary to determine the turbine efficiency and propeller efficiency, and the essentials for correct design. 2500 w. Mech Engr—Nov. 25, 1905. Serial. 1st part. No. 73588 A.

Notes on the Design of Reaction Turbines. Henry F. Schmidt. Explains the conditions peculiar to this type, discussing the principles of reaction, and the methods and calculations necessary. 5000 w. Power—Dec., 1905. No. 73709 C.

Pressures at the Various Stages of Multiple-Stage Steam Turbines. A. M. Levin. An explanation of a ready means for the solution of questions of this class. 1000 w. Power—Dec., 1905. No. 73703 C.

Test of a 500-Kilowatt Curtis Steam Turbine at Ottumwa, Iowa. John Wishart. An account of a test made to determine the performance of the turbine plant and to ascertain its satisfactory operation under guaranteed test conditions. 1700 w. Engr, U S A—Dec. 1, 1905. No. 73616 C.

The Allis-Chalmers Steam Turbine. Illustrated description of the turbine outfit recently installed at Utica, N. Y. 1600 w. Ir Age—Dec. 14, 1905. No. 73722.

The Rateau Steam Turbine and Its Applications. M. J. Rey. A monograph of the steam-turbine created by Mr. Rateau; giving also a classification of the different systems of steam-turbines, and some historical facts regarding the invention. Ills. 24500 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73947 H.

See also Marine and Naval Engineering.

Valve Gear.

Musgrave's Valve Gear for Steam Engines. Illustrates and describes an improved construction and arrangement for steam engines of the type in which the distribution is effected by four separate balanced piston valves, two for admission and two for exhaust. 900 w. Mech Engr —Nov. 25, 1905. No. 73590 A.

Water Softening.

Notes on Water Softening. W. M. effect of neutral salts, the influence of the apparatus used, the determination of lime factor, and the soda factor, &c. 1700 w. Eng & Min Jour—Dec. 2, 1905. No. 73538.

MISCELLANY.

Aeronautics.

Recent Experiments in Aerial Navigation (Un Nouvel Essai de Navigation Aerienne). M. Léger. An illustrated description of the experiments with lifting screw-propellers, made by the author for the Prince of Monaco. 4000 w. Rev Gen des Sciences—Nov. 15, 1905. No. 73875 D.

Recent Experiments with the Lebaudy Balloon (Les Nouvelles Expériences du Lebaudy). Lt. Col. G. Espitallier. An illustrated account of the ascensions of the dirigible balloon of Lebaudy in 1904-1905, including the trip of 210 kilometres from Moisson to Mourmelon. 2000 w. Génie Civil—Dec. 9, 1905. No. 73815 D.

The Useful Coefficient of Screw Propellers (Sur le Coefficient d'Utilisation des Hélicoptères). Edgar Taffoureau. An examination of the best proportions of lifting screw propellers for use for aeronautical purposes, following the work of the late Col. Renard. 1200 w. Comptes Rendus—Nov. 27, 1905. No. 73830 D.

Engineering Building.

The Engineering Building. Illustrated description of the principal features of the fine building being erected in New York City, taken from a recently issued report. 1800 w. Ir Age—Dec. 14, 1905. No. 73719.

Liquid Air

The Liquefaction of Air (Liquéfaction de l'Air). Discussing especially the production of pure oxygen by fractional distillation of liquid air. 2500 w. Génie Civil—Dec. 9, 1905. No. 73817 D.

The Liquid Air Plant of the Chemistry Department, University of California. F. G. Cottrell. Illustrates and describes the plant and its operation, and the uses made of it. 4000 w. Cal Jour of Tech—Sept., 1905. No. 74077 C.

The Separation of Oxygen and Nitrogen by the Partial Liquefaction of Air (Sur l'Application de la Liquéfaction Partielle de l'Air avec Retour en Arrière à la Separation Intégrale de l'Air en Oxygene Pur el Azote Pur). Georges Claude. Describing the operation of a regenerative apparatus for the fractional separation of oxygen. 1200 w. Comptes Rendus—Nov. 20, 1905. No. 73828 D.

Progress.

Progress in Iron and in Mechanical Art. J. H. Wicksteel. Lecture at Leeds before the Assn. of Yorkshire Students. Discusses some improvements now in progress, and of recent date in the present number. 5000 w. Engr, Lond—Dec. 8, 1905. Serial. 1st part. No. 73913 A.

MINING AND METALLURGY

COAL AND COKE.

Coke.

Coke as a Blast-Furnace Fuel—Its Manufacture and Characteristic Properties. Edward A. Uehling. An illustrated article explaining the making of coke, the wastefulness of the beehive coke-ovens, and of the early methods used, and the better results obtained by retort ovens. 3000 w. Stevens Ind—Oct., 1905. No. 73928 D.

The Manufacture of Coke in Northern China. Yang Tsang Woo. Brief illustrated description of the coke-kilns and method used. 700 w. Am Inst of Min Engrs—Nov., 1905. No. 73965.

Coke Oven.

A New By-Product Coke-Oven. R. Schorr. Illustrated description of an oven specially designed to coke lean coals and also non-coking fuels with the addition of oil, oil residues, coal-tar, molasses, &c. 500 w. Eng & Min Jour—Dec. 16, 1905. No. 73774.

Coking.

The Progress of Coke Manufacture in the Saar District (Die Fortschritte der Koksfabrikation im Saargebiet). Oskar Simmersbach. An account of the operation of by-product coke ovens, with tabulated data of dimensions and performance. 3000 w. Stahl u Eisen—Dec. 1, 1905. No. 73850 D.

Model Plant.

A Model Illinois Coal Mining Plant. Charles H. Smith. Illustrated description of No. 8, a new mine plant at Clifford, Illinois. 2000 w. Min Wld—Dec. 23, 1905. No. 74005.

Philippines.

United States Enterprise in the Coal Trade of the Philippines. Oscar Halvorsen Reinholt. A review of the development of coal mining in the islands in connection with the United States government explorations. 4500 w. Engineering Magazine—Jan., 1906. No. 73891 B.

Washeries.

Anthracite-Washeries. George W. Harris. A discussion of the waste in the breaker, represented by the old culm-banks, and the steps taken to diminish it. 4000 w. Ills. Am Inst of Min Engrs—Nov., 1905. No. 73962.

West Virginia.

The Loup Creek Colliery Company. George W. Harris. An illustrated description of this mining property in West Virginia, the methods of mining, coke oven equipment, &c. 3800 w. Eng & Min Jour—Dec. 9, 1905. No. 73643.

COPPER.

Assay.

The Electrolytic Assay of Lead and Copper. George A. Guess. An illustrated description of the writer's method. 1500 w. Am Inst of Min Engrs—Nov., 1905. No. 73960.

Determination.

Notes on Technical Determination of Copper by the Cyanide Method. Irving Miller. Gives a few of the practical details of manipulation in connection with the cyanide assay of copper ores and products. 1200 w. Cal Jour of Tech—Dec., 1905. No. 74080 C.

Distillation.

The Distillation of Copper (Sur la Distillation du Cuivre). Henri Moissan. A discussion of the volatilization of copper in the electric furnace, and the nature of the condensed vapor. 2000 w. Comptes Rendus—Nov. 27, 1905. No. 73829 D.

Mines.

Britannia Copper Syndicates, Mines and Concentrating Works at Howe Sound, B. C. E. Jacobs. Illustrates and describes the mines, concentrating plant, &c., giving the history. 7500 w. B C Min Rec—Nov., 1905. No. 73737 B.

Ore Deposits.

Genesis of the Ore-Deposits at Bingham, Utah. J. M. Boutwell. A statement on the genesis of the copper- and lead-deposits, with conclusions. Ills. 12000 w. Am Inst of Min Engrs—Nov., 1905. No. 73956 D.

Precipitation.

Copper Precipitation Plants at Butte. An account of the commercial extraction of copper from mine and tailings seepage waters by the use of scrap iron and tin as precipitants. 2000 w. Min Rept—Dec. 21, 1905. No. 74009.

Refining.

Electrolytic Copper. Lawrence Addicks. Discusses the subject of the electrolytic refining of copper, especially from the point of view of the multiple system of refining. 4000 w. Jour Fr Inst—Dec., 1905. No. 73933 D.

Separation.

Improvements in Nickel-Copper Separation. Ambrose Monell describes an improvement in the method of separating nickel and copper sulphides, as practiced at the Oxford works. 1200 w. Eng & Min Jour—Dec. 16, 1905. No. 73770.

Smelting.

The Constitution of Mattes Produced in Copper-Smelting. Allan Gibb and R. C. Philp. Report of research work, both from a chemical and physical standpoint, of the constitution of mattes produced in copper smelting, the investigation involving both synthesis and analysis. 5200 w. Am Inst of Min Engrs—Nov., 1905. No. 73957 D.

GOLD AND SILVER.

Assaying.

Assaying Argentiferous-Tin-Copper Alloys. P. J. Thibault. Report of an unsuccessful attempt to apply the method used for the dry determination of silver in tin-lead alloys and metallic tin, to the alloys named. 700 w. Aust Min Stand—Nov. 15, 1905. No. 74083 B.

Some Assay Results on Resampled Ores. Howard C. Parmelee. Read before the W. Assn. of Tech., Chem. & Met. Gives tabulated statement of results, and deductions drawn. Also discussion. 3000 w. Min Jour—Dec. 2, 1905. No. 73684 A.

Australia.

Reduction Plant and Process at the Oroya-Brownhill Mines. Robert Allen. Abstract from *Jour. Cham. Mines*, Kalgoorlie, W. A. Describes the wet crushing process used and the treatment. 2200 w. Min & Sci Pr—Nov. 25, 1905. Serial, 1st part. No. 73510.

Black Sands.

Second Preliminary Report on Investigation of Black Sand. Information from the report of Dr. David T. Day concerning the experiments in concentration which have been conducted at the Lewis & Clark Centennial Exposition, with a view of ascertaining the most economical method of separation. 1500 w. Min Rept—Dec. 7, 1905. No. 73663.

Cobalt.

Cobalt Mining District, Ontario. W. O. Hotchkiss. Map, and illustrated account of this rich cobalt-silver district and its development. 3000 w. Min Wld—Dec. 9, 1905. No. 73658.

Concentrates.

The Cyanidation of Concentrates. Bernard Macdonald. A statement of the commercial results, reporting tests made. 1800 w. Eng & Min Jour—Dec. 23, 1905. Serial. 1st part. No. 73995.

Cost-Accounts.

Cost-Accounts of Gold-Mining Operations. Thomas H. Sheldon. A detailed description of the system used by the Portland Gold Mining Co., Cripple Creek, Colo. 6500 w. Am Inst of Min Engrs—Nov., 1905. No. 73964 D.

Cripple Creek.

Resurvey of Cripple Creek District, Colorado, by the United States Geological Survey. Abstract of report showing new facts determined. 3000 w. Mines & Min—Dec., 1905. No. 73718 C.

Dredging.

Gold Dredging in Colombia. J. P. Hutchins. An account of a recent examination of the deposits on the Magdalena river and its affluents, with conclusions as to dredging probabilities. 3000 w. Eng & Min Jour—Dec. 2, 1905. No. 73533.

Gold Dredges. F. F. Coleman. Describes the general character of the dredge, and the work it is to do, illustrating types, and explaining the kind of work for which each is adapted. 2000 w. Marine Engng—Jan., 1906. No. 74021 C.

Goldfields.

The Northern Goldfields of Colorado. John A. Wolff. Gives the history of this region, describing the deposits, and giving opinion of their great value. 1800 w. Min Wld—Dec. 16, 1905. No. 73782.

Grinding.

Fine Grinding in Metallurgy. E. E. Wann. Aims to open a discussion of the method of extraction by amalgamation and cyanide leaching of gold ores, with a view to improving the treatment of slimes, and constructing a regrinding device superior to those in use. 2000 w. Min & Sci Pr—Dec. 16, 1905. No. 74010.

New Mines.

Notes on Southern Nevada and Inyo County, California. H. H. Taft. Information concerning the volcanic area, the Bullfrog mining district, Tonopah, Goldfield, Death Valley, and surrounding regions. 8500 w. Am Inst of Min Engrs—Nov., 1905. No. 73963 C.

Parting Methods.

Electrolytic Versus Sulphuric Parting of Bullion. F. D. Easterbrooks. Abstract of a paper before the Am. Elec.-Chem. Soc., pointing out some of the principal characteristics of the several parting methods. 1600 w. Eng & Min Jour—Dec. 16, 1905. No. 73771.

Sampling.

Notes on Stope Box Sampling. Wager Bradford. An account of the system of daily stope box sampling as carried out at Langlaate Deep. 3800 w. Jour of Chem, Met, and Min Soc of S Africa—Oct., 1905. No. 73966 E.

Solubility.

The Solubility of Gold in Thiosulphates and Thiocyanates. H. A. White. A report of experiments made to determine the cause of the presence of gold in certain mine reservoirs and the enrichment of soil underneath some residue dumps. 1700 w. Jour of Chem, Met, and Min Soc of S Africa—Oct., 1905. No. 73967 E.

Slimes.

The Buss Slimer. A new slime table, invented by Dr. Julius Buss, is illustrated and described. It is intended for treating any ore or tailing between 50-mesh linear and the finest powder that settles in water. 600 w. Eng & Min Jour—Dec. 16, 1905. No. 73769.

Sulphur.

Sulphur in Roasting. William E. Greenawalt. Discusses the elimination of sulphur in roasting ores, and the determination of the sulphur that will give the best results. 1900 w. Eng & Min Jour—Dec. 23, 1905. No. 73996.

IRON AND STEEL.

Basic Process.

The Direct Charging of the Open-Hearth Basic Furnace from the Blast Furnace (Ueber die Verarbeitung Flüssigen Roheisens im Basisch Zugestellten Martinofen). C. Dichmann. A discussion of the practicability of using direct melted charges of raw iron into the basic open-hearth furnace. Serial. Part I. Stahl u Eisen, Dec. 1, 1905. No. 73849 D.

Concentration.

Notes on Some Recent Experiments on the Magnetic Concentration of Iron Sands from the Lower St. Lawrence. John F. Robertson. Deals with attempts to cheaply overcome the low percentage of iron, and the presence of titanium. Ills. 1600 w. Can Soc of Civ Engrs—Nov. 30, 1905. (Adv. proof.) No. 74087 C.

Furnace Hoist.

Electric Furnace Hoist. L. Ramakers. An illustrated description of an electrically-operated furnace hoist, which was recently constructed at Frankfurt, Germany. 1200 w. Elec Wld & Engr—Dec. 9, 1905. No. 73669.

Iron Industry.

See Industrial Economy.

Iron Works.

The Lothringer Iron Works at Kneuttingen (Die Werke des Lotringer Hüttenvereins in Kneuttingen). Bernhard Osann. A detailed description of the furnaces and rolling mills of a new large works in Belgian Lorraine. 4500 w. Three plates. Stahl u Eisen—Nov. 15, 1905. No. 73847 D.

Ore Deposits.

The Iron Ore Deposits of the World (Die Eisenerzvorräte der Welt). A statistical review, giving brief tables of the principal deposits of iron ore in Europe and America. 2000 w. Glückauf—Dec. 9, 1905. No. 73844 D.

The Menominee Range. John L. Buell. Abstract of a paper read before the Lake Superior Min. Inst. Gives some reasons why the discovery of these iron ore deposits were belated, an account of the discovery, and theeories of the formation. 1500 w. Ir Age—Dec. 7, 1905. No. 73581.

The Origin of Clinton Red Fossil-Ore in Lookout Mountain, Alabama. William M. Bowron. Gives the theory advanced to explain these deposits, personal investigations, a statement of the geological conditions, conclusions, &c. Ills. 6500 w. Am Inst of Min Engrs—Nov., 1905. No. 73961.

See Industrial Economy.

Rail Mill.

Plant of the Algoma Steel Co., Sault Ste. Marie. Illustrates and describes one of the most modern steel plants in Canada. The principal production is steel rails. 3500 w. Ir Trd Rev—Dec. 21, 1905. No. 73974.

MINING.

Accidents.

Fatal Accidents in Coal Mining in 1904. Frederick L. Hoffman. A report of the facts with comment on the causes and conditions. 3500 w. Eng & Min Jour—Dec. 2, 1905. No. 73535.

Electric Power.

Electricity as Applied to Mining. W. C. Mountain. The first of three lectures on this subject, to be given at the University College, Nottingham. A record of progress made in the application of electricity to coal mines, and suggestions for future applications. Ills. 7500 w. Ir & Coal Trds Rev—Dec. 1, 1905. No. 73686 A.

Electricity vs. Compressed Air for Mine Operations. Two papers on this subject are given. W. R. Hulbert discusses it from the electrical point of view; and Edward F. Schaefer from the compressed air point of view. 2800 w. Compressed Air—Dec., 1905. No. 73999.

Improvements in Electric Power for Mining Plants (Neuerungen bei Elektrischen Anlagen im Bergwerks und Hüttenbetrieb). Hr. Philippi. Comparing the Leonard and the Ilgner systems of regulation as applied to electric hoisting engines. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 18, 1905. No. 73801 D.

Explosion.

The Wattstown Colliery Explosion. Notes on the disaster that occurred July 11, 1905, by James Ashworth, and an official report. 9000 w. Ir & Coal Trds Rev—Dec. 1, 1905. No. 73685 A.

Faults.

An Interesting Fault-System. C. G. Gunther. Brief description, with vertical section, of an unusual system opened up in the New York mine, in Siskeyou county. 400 w. Eng & Min Jour—Dec. 2, 1905. No. 73534.

Hoisting.

A Bucket Elevator Installation for a 155-Ft. Zinc Mine Shaft. Illustrated description of a continuous bucket elevator installed at Carthage, Mo., to raise zinc ore from an inclined shaft. 600 w. Eng News—Dec. 7, 1905. No. 73625.

A Novel Water Hoist. Illustrates and describes the electric automatic arrangement for hoisting water at the Hampton-Central water shaft of the D. L. & W. R. R. Co. 1400 w. Mines & Min—Dec., 1905. No. 73715 C.

Electricity in Continental Mines. C. Smith. Illustrated description of some German hoisting plants having interesting features. 3500 w. Mines & Min—Dec., 1905. No. 73714 C.

Mine Hoisting with Driving Sheaves (Die Förderung mit Treibscheibe). H. Baumann. A review of the Koepe system of winding, using driving sheaves instead of drums, showing its application to deep shafts. 2000 w. Glückauf—Nov. 25, 1905. No. 73841 D.

The Aerial Rail Hoist and Haulage System. W. R. Crane. Illustrated description of apparatus recently installed for raising and transporting ore in the Joplin region. 2000 w. Mines & Min—Dec., 1905. No. 73712 C.

Launders.

Sand Launders. Thomas T. Read. Information regarding the use of launders for the movement of solid material in water currents. 900 w. Eng & Min Jour —Dec. 16, 1905. No. 73775.

Mine Examination.

The Examination of Mines Preliminary to Purchase: To-day as Compared with Twenty-five Years Ago. R. Gilman Brown. Read before the Am. Min. Cong. A paper containing information of value to engineers, students, miners, and the general public. 3500 w. Min & Sci Pr—Nov. 25, 1905. No. 73509.

Mining Débris.

Control of Hydraulic Mining Débris in California by the Federal Government. Capt. Wm. W. Harts. Read before the Mining Conference. Explains the problem, the extent of the damage, discussing the duties of the commission, and the general principles of improvement. Ills. 6000 w. Cal Jour of Tech—Sept., 1905. No. 74079 C.

Ontario.

Some Timiskaming Ores. Phillips Thompson. Information from a paper by Prof. W. G. Miller concerning the silver-cobalt-nickel-arsenic ores of northern Ontario. 1800 w. Map. Eng & Min Jour —Dec. 2, 1905. No. 73537.

Ore Deposits.

Some of the Veins and Ore Deposits of the Wood River District, Idaho. Arthur Lakes. Describes the occurrence and mode of vein formation and ore deposition in this region. 2000 w. Min Wld —Dec. 23, 1905. No. 74007.

The Limestone-Granite Contact-Deposits of Washington Camp, Arizona. W. O. Crosby. A discussion of the general geology, the ore deposits, the metamorphism of the limestone and chert, &c. 9000 w. Am Inst of Min Engrs—Nov., 1905. No. 73959 C.

Theories of Ore Deposition Historically Considered. S. F. Emmons. Address befor the Geol. Soc. of America, at St. Louis. Gives the opinions held on this subject which have most impressed the minds of geologists. 3500 w. Sci Am Sup—Dec. 16, 1905. Serial. 1st part. No. 73730.

Respiration Apparatus.

A New Respiration Apparatus. A brief description of the two present forms of the Bamberger-Böck pneumatogen. Ills. 1400 w. Sci Am Sup—Dec. 23, 1905. No. 73988.

Rock Drills.

Improved Electric Rock Drills (Neuere Elektrische Stossbohrmaschinen). W. Wolf. Describing improved forms of solenoid rock drills, with details of construction. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 18, 1905. No. 73846 D.

Notes on the Construction and Practical Operation of Rock-Drilling Machines. Lengthy discussion of E. M. Weston's paper on this subject. 13000 w. Jour of Chem, Met & Min Soc of S Africa —Oct., 1905. No. 73968 E.

Sand Pumping.

A New Method of Pumping Sand by Means of Compressed Air at the Plant of the United States Silica Co. Lucius I. Wightman. Illustrated description of an installation at Ottawa, Ill., especially adapted for this work. 1200 w. Eng News—Dec. 7, 1905. No. 73622.

Shafts.

Modern Methods in Shaft Sinking. James Tonge. An illustrated account of some recent improvements in shaft-sinking methods in Great Britain. 2500 w. Mines & Min—Dec., 1905. No. 73717 C.

Shaft Guides. Bergassessor Ackermann, in *Zeit. Berg-, Hütten- und Salinenwesen.* Gives experience gained with various kinds of shaft guides in the Breslau Mining District. Ills. 9000 w. Col Guard—Dec. 15, 1905. No. 74051 A.

Some Considerations in the Equipment of Incline Shafts. F. N. Hambly. Discusses the size and grade of shaft, head-gear bins, skips, tracks, and ore bins underground. 4000 w. Jour S African Assn of Engrs—Oct., 1905. No. 74039 F.

Shot-Firing.

Safe Shot-Firing in Coal Mines. George G. André. Briefly considers the quantity of explosive used, slow firing, firing by electricity, &c. 1200 w. Col Guard—Dec. 15, 1905. No. 74050 A.

Signals.

Electric-Optical, Acoustic Signals at the Julius III. Shaft at Brüx (Elektrisch, Optisch, Akustische Seilbahn Signalanlage am k. k. Schachte Julius III. in Brüx). Gustav Ryba. Describing a signal system for use in connection with an underground cable traction haulage installation. Two articles. 4000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 18, 25, 1905. No. 73845 each D.

Tropics.

Life and Mining in the Tropics. G. M. Colvocoresses. Considers the climate and its influence, and gives suggestions for keeping in good health. 3000 w. Eng & Min Jour—Dec. 23, 1905. No. 73993.

Veins.

The Origin of Vein-Filled Openings in Southeastern Alaska. Arthur C. Spencer. To account for certain features observed in the Juneau gold-belt in Alaska, the paper indicates in detail certain conditions in which deformation of rocks under their own weight might lead to the production of fractures in which veins could be deposited. Ills. 1500 w. Am Inst of Min Engrs—Nov., 1905. No. 73958.

Water Supplies.

The Importance of Potable Water Supplies to Mining Communities. Charles E. Morrison. Discusses the usual sources of supply for mining camps, and the dangers of some of them. 1500 w. Eng & Min Jour—Dec. 9, 1905. No. 73642.

MISCELLANY.

Lead.

Lead Smelting in Reverberatory Furnaces at Desloge, Mo. W. R. Ingalls. Describes the technical results of furnaces of the Flintshire type at Desloge. 2200 w. Eng & Min Jour—Dec. 16, 1905. No. 73772.

The Savelsberg Process. W. R. Ingalls. Outlines this process for the desulphurization of galena by lime-roasting. 2200 w. Eng & Min Jour—Dec. 9, 1905. No. 73645.

Mineral Industry.

See Industrial Economy.

Natural Gas.

The Transportation of Natural Gas. D. S. Ferry. Illustrates and describes the feeders from the largest gas well, in West Virginia, and the great gas engines at Hastings. 1200 w. Power—Dec., 1905. No. 73701 C.

Petroleum.

The Oil Fields of the West. Day Allen Willey. An illustrated account of the development of the oil-bearing sands west of the Mississippi River. 1800 w. Sci Am—Dec. 16, 1905. No. 73726.

Platinum.

Assay of the Platinum Metals. From *Oest. Zeit. f. Berg- und Hüttenwesen.* A description, by Dr. Nordenskjöld, of some analyses which do not appear to be well known, and which are more rapid than and milling practice. 3500 w. Eng & Min Jour—Dec. 2, 1905. No. 73536.

Progress.

Recent Progress in Metallurgy. A. E. Outerbridge, Jr. Address, reviewing briefly the field covered by the metallurgical industries and the progress during the past year. 7500 w. Jour Fr Inst—Dec., 1905. No. 73932 D.

Talc.

Talc in Northern New York. Robert B. Brinsmade. An illustrated description of the deposits of the Talcville region, discussing their origin, and the mining and milling practice. 3500 w. Eng & Min Jour—Dec. 23, 1905. No. 74994.

Zinc.

The Electrometallurgy of Zinc (Zur Elektrometallurgie des Zinks). Dr. Franz Peters. A general review of progress in the electrolytic separation of zinc during the past five years. Serial. Part I. 4000 w. Glückauf—Dec. 2, 1905. No. 73842 D.

The Zinc Industry of the Rocky Mountain Region. W. G. Swart. Read before the Am. Min. Cong. An account of the processes used for removing the impurities and the methods of successfully handling these low-grade ores. 1800 w. Eng & Min Jour—Dec. 9, 1905. No. 73644.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Injuries to Passengers. Calls attention to the causes of many accidents, showing how they could be prevented. 4000 w. R R Gaz—Vol. XXXIX., No. 24. No. 73741.

Cuba.

Railroading in Cuba. Relates incidents in regard to travel on Cuban railways, both humorous and exasperating. 2500 w. Ry & Engng Rev—Dec. 16, 1905. No. 73786.

End Shocks.

End Shocks in Car Service and Provision for Same in Car Framing. A. Stucki. Indicates the conditions which cars should be required to meet and which could be used as a basis for handling the cars. 7200 w. Pro Ry Club of Pittsburgh—Sept., 1905. No. 73757 C.

Southern Roads.

The Southern Roads and the Territory They Serve. W. D. Taylor. Describes the conditions which have been the cause of slow railroad development in the South, and the present conditions, with information concerning the lines which control most of the southern traffic. 4200 w. Ry Age—Dec. 8, 1905. No. 73661.

MOTIVE POWER AND EQUIPMENT.

Cars.

Baggage Car for Automobiles. Brief illustrated article showing the construction.

400 w. Am Engr & R R Jour—Dec., 1905. No. 73530 C.

Construction of a Passenger Car. C. F. Rydberg. Read before the Canadian Ry. Club. A general discussion of the more important points in the construction. 5000 w. Ry & Engng Rev—Dec. 2, 1905. No. 73502.

Fire-Boxes.

Early Experiments with Smoke-Consuming Fire-Boxes on American Locomotives. C. H. Caruthers. An interesting illustrated review of types of boilers, fireboxes, &c., brought out between 1857 and 1859 aiming to consume the smoke and gases of bituminous coal. 2500 w. R R Gaz—Vol. XXXIX., No. 22. No. 73545.

Locomotives.

Baltimore and Ohio Consolidation Locomotive. Illustrated descriptions of locomotives from special designs, 210 of which are being built. An account of the requirements to be met is also given. 1700 w. Ry Age—Dec. 22, 1905. No. 73991.

Comparative Magnitude of Longitudinal Disturbing Forces in a Cole Balanced Compound and a Single Expansion Express Locomotive. Edward L. Coster. Gives an analysis of the relative horizontal inertia effects. 800 w. Am Engr & R R Jour—Dec., 1905. No. 73531 C.

Consolidation Locomotive for the Baltimore & Ohio Railroad. Gives particulars of interest regarding these engines. 1500 w. R R Gaz—Vol. XXXIX., No. 24. No. 73740.

Electric vs. Steam Locomotives. R. H. Probert. Read before the Ohio Soc. of Elec., Mech., and Steam Engrs. Considers a general example showing the lower cost of operation and other advantages from electrical equipment. 4500 w. Engr, U S A—Dec. 1, 1905. No. 73621 C.

Four-Coupled Express Locomotive for the Belgian State Railways. H. W. Hanbury. Illustration with description of an engine for express passenger service, of simple type with inside cylinders and Stephenson motion. 800 w. Engng—Dec. 1, 1905. No. 73689 A.

Four-Cylinder Compound Locomotive for the Paris, Lyons, and Mediterranean Railway. H. W. Hanbury. Illustrated detailed description of a six-coupled locomotive believed capable of maintaining an average speed of 50 miles per hour on varying gradients, with a load of 300 tons. 1500 w. Engng—Nov. 24, 1905. No. 73604 A.

German Compound Locomotive with Superheater. Illustrates an interesting type of high-speed locomotive, giving brief description. 300 w. Ry Age—Dec. 1, 1905. No. 73507.

Goods Locomotives on British Railways. Charles S. Lake. The practice of recent years in England is illustrated and described. 1600 w. Mech Engr—Dec. 9, 1905. Serial. 1st part. No. 73900 A.

Lackawanna Eight-Wheel Passenger Locomotives with Superheater. The engine 955 equipped with Cole superheater, with piston valves, is illustrated and described. 500 w. Ry Age—Dec. 15, 1905. No. 73780.

Locomotives of the Belgian State Railway at the Liége Exhibition. F. Matthei. Illustrations, descriptions of types, and general remarks. 9400 w. Table. Bul Int Ry Cong—Nov., 1905. No. 73752 E.

Newest Caledonian Engines and Their Work. Charles Rous-Marten. Describes in detail the latest engines of the Caledonian Railway, and some of the work done by them. 4300 w. Engr, Lond—Dec. 8, 1905. No. 73909 A.

Pacific Balanced Compound for the Santa Fé. Illustrated description of a large passenger engine with four compound cylinders and Vauclain's engine arrangement. 300 w. Ry Age—Dec. 8, 1905. No. 73660.

Panama Canal Engines. Illustrated description of a 2-6-4 type of engine to be used in the construction of the canal. 144 are to be built. 700 w. Ry & Loc Engng—Dec., 1905. No. 73524 C.

Ten-Wheel Coupled Locomotive for the Great Western Railway of Argentina. Illustrations showing the general appearance and leading dimensions of an experimental locomotive to meet special conditions. 200 w. Engng—Nov. 24, 1905. No. 73601 A.

Ten-Wheeled (4-6-0) Locomotive for the New York Central & Hudson River. Illustrates and describes this type of locomotive, fifteen of which have been recently built for fast freight and heavy passenger service on the road named. 800 w. R R Gaz—Vol. XXXIX., No. 24. No. 73739.

The Capacity of Locomoives at Various Speeds (Ueber die Bestimmung der Leistungen von Lokomotiven aus dem Verlaufe der Geschwindigkeitskurven). Karl Schlöss. A study of the tractive power of locomotives based upon the performance at various points in the speed curve. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 24, 1905. No. 73822 D.

The Compound Locomotive of To-day. J. F. Gairns. The present article is introductory and reviews the position occupied by the compound locomotive to-day. The principal systems in use will be considered. 2000 w. Prac Engr—Dec. 15, 1905. Serial. 1st part. No. 74041 A.

The Evolution and Development of the Steam Locomotive as Evidenced by the Exhibits in the Transportation Building at the St. Louis World's Fair. William A. Doble. Read before the Pacific Coast Ry. Club. An interesting illustrated review. 7800 w. Jour of Elec—Dec., 1905. Serial. 1st part. No. 73656 C.

The New Ten-Wheeled Express Locomotives of the Bavarian State Railways. E. Weiss. Gives a statement of the performances demanded, general arrangement and chief dimensions, with illustrated description. 2800 w. Bul Int Ry Cong —Nov., 1905. No. 73754 E.

The Origin of Four-Cylinder Balanced Compound Locomotives. Charles R. King. A review of designs of four-cylinder engines, and of balanced compounds, aiming to trace the first four-cylinder balanced compounds built. Ills. 4500 w. R R Gaz—Vol. XXXIX., No. 23. No. 73653.

The Recent Development of the Locomotive Engine. Calls attention to certain points in recent development, and the fact that the performance, economies and wastes cannot be treated on any basis of comparison drawn from the performance of stationary or marine engines. 3500 w. Engr, Lond—Dec. 1, 1905. No. 73691 A.

Motor Coaches.

Recent Developments in Motor Coaches Upon British Railroads. Illustrates and describes some recent types, especially the Peebles Steam Car. 2000 w. Sci Am Sup—Dec. 2, 1905. No. 73555.

Train Heating.

The Heating of Railway Trains (Heizung der Eisenbahnwagen). E. Ritt. Illustrated details of steam heating apparatus as used in German railway trains. 1800 w. Gesundheits-Ingenieur—Nov. 10, 1905. No. 73876 B.

Train Lighting.

The L'Hoest and Pieper System of Electric Train Lighting (Die Elektrische Zugbeleuchtung von L'Hoest und Pieper). E. Wikander. A steam-driven generating set is mounted on the locomotive boiler, the current being regulated on each car, and a small storage battery supplying current for three hours in case of detachment. 1800 w. Elektrotech Zeitschr—Nov. 16, 1905. No. 73852 B.

The L'Hoest-Pieper System of Train Lighting. Describes this system which aims to eliminate the axle-driven generator, and to reduce the equipment of each car to a small battery just sufficient for lighting the car in case it is disconnected from the locomotive. 800 w. Elec Wld & Engr—Dec. 2, 1905. No. 73614.

The Mixed System of Electric Train Lighting (Elektrische Beleuchtung von Personenwagen nach dem Gemischten Betrieb). Emil Dick. A comparison of the use of storage batteries and of the mixed system of dynamo and storage battery for the lighting of passenger trains. 4000 w. Zeitschr f Elektrotechnik—Nov. 26, 1905. No. 73863 B.

Valve Gear.

Walschaert Valve Gear. Max Pfander. Diagram and description, with a statement of its advantages as compared with ordinary link motion. 2000 w. Ry & Loc Engng—Dec., 1905. No. 73523 C.

Valves.

Westinghouse Improved Brake Valves. Gives views of the automatic and straight air brake valves and an explanation of how they should be handled while operating the brakes. 500 w. Ry & Loc Engng —Dec., 1905. No. 73525 C.

NEW PROJECTS.

Cut-Off.

The Low Grade Freight Cut-Off of the Pennsylvania R. R. Illustrates and describes the construction of a low-grade double-track freight line in Southeastern Pennsylvania, which involved some of the heaviest railroad work ever undertaken in the United States. 4000 w. Eng Rec—Dec. 16, 1905. Serial. 1st part. No. 73916.

The Pennsylvania Railroad Low Grade Freight Line from Harrisburg to Atglen, Pa. Explains the purpose and character of this work, giving an illustrated description of important railway grading, with very heavy work on a small portion of the line. 3500 w. Eng News—Dec. 28, 1905. No. 74030.

Japan.

Railroad Development in Japan. George E. Walsh. An account of present development and future outlook which seem to indicate a great awakening. 1500 w. R R Gaz—Vol. XXXIX., No. 23. No. 73654.

New Roads.

The Missouri, Oklahoma & Gulf Railway. Illustrates and describes a road under construction, discussing its traffic possibilities, ownership of real estate and the changed conditions, &c. 2400 w. Ry Age —Dec. 15, 1905. No. 73779.

PERMANENT WAY AND BUILDINGS.

Car House.

The Federal Street Car House of the Rochester Railway Company. I. E. Matthews. Gives plans and description of a building large enough to hold about 100 double-truck cars. 1600 w. St Ry Jour—Dec. 2, 1905. No. 73521 C.

Cologne.

The Transformation of the Railway Facilities about Cologne (Ueber die Umgestaltung der Bahnanlagen bei Köln). H. Kumbier. Describing the importance of Cologne as a railway centre, with especial reference to the new passenger stations. 3500 w. Glasers Annalen—Nov. 15, 1905. No. 73818 D.

Curves.

The Determination of Curve Deflections and Rail Joints (Beitrag zur Lehre von der Berechnung der Bogenweichen und Geleisverbindungen). A mathematical discussion of the laying out of railway curves and junctions. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 1. 1905. No. 73824 D.

Freight Station.

New Freight Station at Cincinnati, O.; Cincinnati Southern Ry. Illustrated description, with statement of the requirements as given in the specifications. 1000 w. Eng News—Dec. 7, 1905. No. 73623.

Improvements.

New York Central Roadbed Improvements in the Vicinity of New York City. Illustrates and describes improvements made north of Mott Haven, including additional tracks, tunnels, new roadbed, cutoffs, depression, &c. 1600 w. Ry & Engng Rev—Dec. 16, 1905. No. 73784.

Some Money Saving Schemes, Minneapolis & St. Louis R. R. Brief descriptions of devices for saving labor in shops and tending to economy. A tool for truing wrist pins; a tool for threading radical stays, having button heads; a device for facing off the joints on cinder hoppers; and other tools and methods are described. Ills. 1500 w. Ry Mas Mech —Dec., 1905. No. 73500.

Rock Island.

Rock Island Company. An outline of the various lines composing this system with information from recent reports concerning the operation, earnings, &c. 2800 w. R R Gaz—Vol. XXXIX., No. 22. No. 73541.

Shops.

Locomotive Works, and Shop Practice in Italy. The present number is principally a description of the "Elvetica" works of The Ernesto Breda Company, of Milan, and the methods used there. Ills. 4400 w. Engr, Lond—Dec. 15, 1905. Serial. 1st part. No. 74055 A.

The Kingsland Shops of the Lackawanna R. R. These coach and locomotive shops in New Jersey are illustrated and described. They will cover an area of 8.5 acres, and will cost $1,000,000 when completed and equipped. 3500 w. Eng Rec—Dec. 2, 1905. No. 73574.

Winnipeg Shops of the Canadian Pacific. Illustrates and describes large modern shops for repair work. 1000 w. R R Gaz—Vol. XXXIX., No. 26. No. 74084.

Signaling.

A Cheap Method of Interlocking Switches and Signals. P. Grade. Describes a system of interlocking without placing the levers together in one cabin, or having to carry keys about. Gives applications, trials, and statement of advantages and cost. 3400 w. Ills. Bul Int Ry Cong—Nov., 1905. No. 73753 E.

The Upward Indication of the Semaphore Arm. L. R. Clausen. Reviews the history of this method of signaling, and discusses the question of changing from the downward to the upward indication for proceed, giving arguments in favor of the change. Ills. 2000 w. Wis Engr—Dec., 1905. No. 73751 D.

Terminals.

A Highland Railway Terminus. Brief illustrated description of the picturesque terminals of the Oban Railway, at Oban, Scotland. 400 w. Ry & Loc Engng—Dec., 1905. No. 73522 C.

Blair Furnace Freight Locomotive Terminal, Pennsylvania R. R. Illustrated description of a large locomotive terminal recently put into operation. 1500 w. Ry & Engng Rev—Dec. 23, 1905. No. 74001.

The Washington Terminal. Theodore Starrett. An illustrated description of this beautiful terminal station in process of construction. 1800 w. Arch Rec—Dec., 1905. No. 73609 C.

Tracks.

Effect of Rolling Stock on Track. Hugh Steele. Read before the New England R. R. Club. Discusses damage done by worn wheels, trailing obstructions from trains, water, &c., especially in large yards and terminals. 1300 w. Ry & Engng Rev —Dec. 16, 1905. No. 73785.

Kansas City-Topeka Double Track Work of the Union Pacific. An illustrated account of improvements amounting practically to rebuilding the line between the cities named. 3000 w. R R Gaz—Vol. XXXIX., No. 23. No. 73652.

The Evolution of Railway Track (L'Evolution des Voies de Chemins de Fer). M. Mesnager. An examination of the deformation of rails and joints under the action of high-speed trains. 1800 w. Génie Civil—Dec. 9, 1905. No. 73816 D.

Track Construction with Steel Longitudinals on the Pennsylvania R. R. Gives illustrations showing a construction that is to be tried which is a remarkable departure from the systems in use. It is the invention of Gustav Lindenthal. Also editorial. 1600 w. Eng News—Nov. 30, 1905. No. 73551.

Water Station.

The Water Supply Plant at the Speldorf Station (Die Wasserversorgungsanlage auf Bahnhof Speldorf). S. Lamm.

Details of the water tower and pumping plant for locomotive supply at the Speldorf division station on the Essen line of the Westphalian railways near Duisburg. Serial. Part I. 1000 w. Glasers Annalen —Nov. 15, 1905. No. 73819 D.

Yards.

New Freight Yard at Alexandria, Va., for the Washington Southern Ry. and the Richmond, Fredericksburg & Potomac R. R. W. A. MacCart. Plan and profile with descriptive notes. 1200 w. Eng News—Nov. 30, 1905. No. 73553.

TRAFFIC.

Accounting.

Underlying Principles and General Practices of Railway Accounting Departments. From a lecture by J. L. Burgess, at the Iowa State College. Considers the importance of the accounting department, the duties of accounting officers, the methods, &c. 3000 w. Ry & Engng Rev— Dec. 23, 1905. Serial. 1st part. No. 74000.

Development.

Union Pacific. Maps and review of the annual statement of this road, with editorial on the policy of main line development and the extension of branch lines. 5500 w. R R Gaz—Vol. XXXIX., No. 24. No. 73738.

Industrial Commissioner.

The Industrial Department. A review of the history of the railroad industrial department, with editorial on the work of the industrial commissioner. 5800 w. R R Gaz—Vol. XXXIX., No. 25. No. 74013.

Loading.

Classification of Locomotives for Tonnage Rating Purposes. J. H. Lonie. Explains a method of classification used on the Rock Island System. 1000 w. Am Engr & R R Jour—Dec., 1905. No. 73529 C.

Rate Regulation.

The President on Rate Regulation. Condensed abstract of the portion of the President's message which treats of railroad rate regulation. 2000 w. R R Gaz —Vol. XXXIX., No. 23. No. 73651.

Tonnage.

The Coal Carriers. Frederick E. Saward. Shows the importance of tonnage to the railroads, giving some idea of the annual haulage, especially from the coal territory. 2200 w. R R Gaz—Vol. XXXIX., No. 23. No. 73650.

STREET AND ELECTRIC RAILWAYS

Acceleration.

An Electric Accelerometer. B. B. Owens. Describes a simple and reliable method of measuring acceleration of a railway car or other machine. Ills. 600 w. Can Soc of Civ Engrs—Nov. 2, 1905. No. 73745 D.

Belfast.

The Belfast City Tramways. Information of interest concerning these recently completed lines, with plans and sections of the generating station. 6800 w. Elect'n, Lond—Dec. 1, 1905. No. 73682 A.

Construction.

Construction Work on the Rochester, Syracuse and Eastern Railroad. Explains the plan of construction of a road designed ultimately to furnish a double-track, high-speed, interurban electric road between Syracuse and Rochester. Ills. 3800 w. St Ry Jour—Dec. 16, 1905. No. 73790 C.

Direct Current.

A New and Higher Standard of D. C. Operation. Frank J. Sprague. The New York Central-New Haven Situation. Charles A. Mudge. Two letters on heavy electric railway work, with editorial discussion of them. 3000 w. St Ry Jour— Dec. 23, 1905. No. 74003 C.

Drainage.

Drainage of the Interborough Rapid Transit Railroad Under the Harlem River. An illustrated article explaining the drainage and pumping system adopted, and the precautions taken to meet possible conditions in the two tubes under the Harlem River. 1000 w. Stevens Ind— Oct., 1905. No. 73931 D.

Electric Traction.

The New York, Westchester & Boston Railway. Information concerning a four-track suburban electric line under construction on a right-of-way 100-ft. wide. Ills. 3000 w. Eng Rec—Dec. 2, 1905. No. 73570.

Electrification.

First Electrical Operation on the West Shore Railroad. Illustrates and describes the section between Frankfort and Herkimer, 3.17 miles long, used by steam trains of the West Shore R. R., and also by electric cars of the Utica & Mohawk Valley Ry. 1000 w. St Ry Jour—Dec. 16, 1905. No. 73792 C.

The Electrification of the New York

Central's Terminal Lines. An illustrated article summarizing the important work of electrifying the terminal lines of this railway. 6500 w. Sci Am Sup—Dec. 9, 1905. No. 73633.

Falkirk.

Falkirk Electric Tramways. Illustrated detailed description of overhead construction, following standard tramway practice for a moderately dense service. 2000 w. Tram & Ry Wld—Dec. 7, 1905. No. 73972 B.

Fire Hazard.

The Fire Hazard in Car Barns. Joseph B. Finnegan. Discusses the proper construction, the hazards due to repair work, heating and lighting, use of oils and grease, lamp filling, sand drying, defective wiring, &c. 2500 w. St Ry Rev—Dec. 15, 1905. No. 73777 C.

Freight Haulage.

Cost of Freight by Electric Haulage. George E. Walsh. Discusses the carrying of freight by interurban electric lines, giving reports from various lines. 2000 w. Elec, N Y—Dec. 6, 1905. No. 73547.

Interurban.

A Desirable Car for Interurban Service. P. J. Mitten. Read before the Indiana Elec. Ry. Assn. Gives the writer's views, and abstract of discussion. 3500 w. St Ry Jour—Dec. 23, 1905. No. 74004 C.

The Dayton & Muncie Electric Railway. Particulars in regard to this recently completed line, with illustrated detailed description of its stations, equipment, rolling-stock, &c. 3000 w. St Ry Jour—Dec. 2, 1905. No. 73519 C.

The Detroit, Flint & Saginaw Railway Co. Illustrated description of the territory served, roadway construction, new power house and equipment. Edward J. Hunt. 2500 w. St Ry Rev—Dec. 15, 1905. No. 73776 C.

Paris.

The Crossing of the Seine by the Metropolitan Railway (Traversée de la Seine par la Ligne Métropolitaine). A. Dumas. Describing the construction of the tunnel under the Seine for the North and South transversal of the Paris Metropolitan railway. 3000 w. 1 plate. Génie Civil—Dec. 2, 1905. No. 73813 D.

Philadelphia.

The Electric Tramways of Philadelphia (Les Tramways Electriques de Philadelphie). P. Ayné. An illustrated description of the electric street and suburban railways of Philadelphia, from a French point of view. 3000 w. Génie Civil—Nov. 25, 1905. No. 73811 D.

Railway Motors.

See Electrical Engineering, Motors.

Singapore.

A Brtish Enterprise in the Far East. An illustrated description of the electric tramways in Singapore. 2200 w. Tram & Ry Wld—Dec. 7, 1905. No. 73971 B.

Single-Phase.

A Short Single-Phase Railway on Long Island. Illustrated description of a road that has been in service for the past two months to convey passengers from Sea Cliff and Glen Cove stations to neighboring steamboat landings on Long Island Sound. 2000 w. St Ry Jour—Dec. 16, 1905. No. 73791 C.

Single Phase Motors for Tramways (Einphasen - Wechselstrom - Betrieb auf Strassenbahnen). E. C. Zehme. A detailed description of the system under test in Paris by the French Thomson-Houston Company. 2000 w. Elektrotech Zeitschr—Dec. 7, 1905. No. 73857 B.

Single-Phase v. Continuous Current for Traction Purposes. Editorial discussion of the merits of a well-designed single-phase system as compared with the continuous current. 2000 w. Engng—Nov. 24, 1905. No. 73602 A.

The Single-Phase Alternating and the Direct Current Systems. A letter from Mr. George Westinghouse setting forth the advantages of the single-phase alternating system, and giving also letters to President Newman of the N. Y. C. R. R. from Mr. Westinghouse, and to Mr. E. M. Herr, from B. G. Lamine. 5200 w. R R Gaz—Vol. XXXIX., No. 25. No. 74011.

Subway.

The New Philadelphia Subway. J. A. Stewart. An illustrated outline of the subway scheme, with the general plan of construction. 1800 w. Sci Am—Dec. 23, 1905. No. 73984.

The Opening of the Philadelphia Subway. An illustrated account of the opening of the first section of this subway, describing the construction. 1800 w. St Ry Jour—Dec. 23, 1905. No. 74002 C.

Telpherage.

The Transmission of Messages by High-Speed Electric Carriers (Le Transport des Correspondances à Très Grande Vitesse par Chariots Electriques Automoleurs). A. Bidault des Chaumes. Describing a scheme for electric-telpherage, for carrying letters and packages. 1500 w. 1 plate. Génie Civil—Nov. 18, 1905. No. 73810 D.

Underground.

An Electric Underground Freight Railway System. Frank C. Perkins. Illustrates and describes details of track and trolley construction in the Chicago subway. 2000 w. Mod Mach—Dec., 1905. No. 73697.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.

Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad.des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

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PLAIN FACTS ABOUT THE PANAMA CANAL.

By John F. Wallace. With an Editorial Introduction.

IN this latest and most significant contribution by Mr. Wallace to the solution of the Panama Canal problem, the author speaks plainly of conditions as he found them and of the difficulties he met. He concentrates here the essence of his year's experience as chief engineer, so far as it concerns the present all-important question of the best mode of building the Canal. In demonstrating his point he divides the whole situation into three simple elements:—the proved inefficiency of direct construction by the Government; the entire applicability and certain economy of the contract system; and the sufficiency of the studies already made, and the data already collected, to enable contractors to bid intelligently and closely, and to enable the Government to judge of the reasonableness of the bids submitted. To this he adds a very practical proposal for the handling of the collateral factor—the Panama Railroad—in case the whole work is turned over to one chief contractor.

Under the first head, Mr. Wallace shows accurately the ways in which red-tape and political administration operate to make efficiency and economy impossible, and brings out the vital point that the trouble is inherent in the Governmental system and could not be dispelled by any change of personnel. Under the second head, he shows the diametrically opposite policy adopted by large corporate contracting and constructing organizations, and the economies of time, effort, and money thus secured; and he cites (in support of the suggestion of letting the whole project by contract), the most successful and satisfactory instance in the entire history of engineering work under the auspices of the United States. Under the third head, he takes up chiefly the matter of unit costs, and points out the value which the work done under his administration might have in enabling either bidders or letters of the contract to reach reliable conclusions on these essential elements of total price.

It is hardly necessary to point out, further, that taking together the studies of the French Company, those of the two Isthmian Canal Commissions appointed by the United States, and those carried forward by the first and second Commissions charged with the construction of the Canal, there is a body of exact knowledge concerning the Isthmus—its geology, climate, rainfall, and every element entering into the calculations of the cost of the Canal—such as seldom, if ever before, was obtainable by prospective bidders on a large project.

Mr. Wallace speaks from the standpoint of the man who is intimately familiar with the conduct of work of the first magnitude under the tried and proved methods of business, and who has also tested "to the breaking point" the methods of political administration in the same field. The double experience gives him unusual insight and authority. We commend his views to the careful attention of all who are interested—officially, politically, professionally, commercially, or patriotically—in the speedy and successful completion of the Panama Canal.—THE EDITORS.

IN the introductory article of the series upon the Panama Canal, which appeared in this Magazine last autumn, I sketched broadly the questions naturally presenting themselves to an unbiased student of the whole problem presented by the Isthmian Canal.

The logic of events has eliminated the necessity for consideration of several of the points then indicated. The completion of the Isthmian Canal by America's greatest nation is a foregone conclusion. The expenditure of some $70,000,000 on a Panama route has settled the question of the general location, and it is inadvisable to confuse the public mind in any way by suggesting even the possibility of abandoning the Panama project and turning to another. The technical examinations of the engineers under American control have also confirmed the advisability of adopting the general features of the French location, and only minor deviations can be made therefrom. The enginering investigations conducted under the second Walker Commission and under my general supervison have accumulated sufficient data to show that all the engineering problems are easily within the range of solution and practical execution, and that the various plans that have been advanced by reputable engineers from time to time are possible of execution.

The first great problem now before the American people is the selection of a general plan; and the questions determining the adoption of a high or a sea-level "type" involve merely the factors of time and cost. The studies thus far made show that the sea-level canal will cost, approximately, from $50,000,000 to $100,000,000 more than a multiple-level and will require from three to five years more in execution—the variations between the maxima and minima of difference in comparative time and cost depending upon the details of the different plans considered. These figures, however, are based on the proposition that some method of administration and execution can be evolved that will permit the work to be conducted with the efficiency with which a large contractor could do the work, having ample funds and talent at his disposal, and being unhampered by restrictive governmental methods.

The second great problem demanding solution is that of the proper mode of administration and construction. To my mind, the effects upon time and cost which may be exerted by policies of administration and method are much more important than any influences on time and cost pertaining inherently to the plans themselves. To state the proposition perhaps more clearly:—it is my opinion that it will take longer, and cost more money, to construct a high-level canal on the 85-foot plan, under the present methods of Governmental control, than it will to construct a sea-level canal, provided the work is accomplished by modern efficient business methods.

While it may be difficult to demonstrate this to the general public by a detailed description of the trivial things that make up the aggregate retardant influences of the Governmental method, the experience of the nation in the constructive field surely furnishes sufficient examples to prove this proposition practically. A single filament of hemp, easily broken and pulled apart by a child, may appear insignificant; but a million thereof, bound and woven together, can be made into a cable which will restrain a gigantic steamship of 20,000 tons burden. What is ordinarily designated as "Government red tape" is simply system gone to seed; it is due to the persistent tendency of the personnel applying that system to give greater consideration to the form and the routine than to the accomplishment of the results the system was designed to maintain.

Of the factors which exercise the greatest deterrent influence in the accomplishment of satisfactory results under direct Governmental control the first is found in the laws governing the disbursement of public funds, aggravated by precedents of 100 years and the multiplicity of decisions which have been made from time to time on specific points as they have been presented for decision to the authorities controlling the Treasury Department. The fundamental principle in the disbursement of Government funds has been to throw around each transaction every possible safeguard to see that the funds are properly expended. This intention—excellent in itself—has been carried to such an extent that the utmost effort is apparently made to prevent and retard the expenditure of every dollar, and to keep track of it until it is lost in the dim distance—and then to have a string to it that will pull it back if there is any question about its proper expenditure.

The fundamental principle in business economy, on the other hand, is when once an expenditure is decided upon, to complete it in the shortest possible time so that every dollar may be earning interest in the new form with the maximum celerity and the minimum loss in the stage of transition.

The official and the commercial ideals are evidently diametrically opposed. Whether, after all, the Governmental method secures greater honesty, or less scandal in connection with disbursements, can best be judged by a comparison of the history of the Government bureaus with that of our great business or engineering enterprises under corporate management.

In modern ordinary affairs, further, the principle of "audit before payment" is adopted; that is, a certain total expenditure for the execution of a carefully matured and fully planned project having been decided upon, that expenditure is authorized as a whole and the administration of details is left to the responsible managing official. This official, indeed, is chosen largely because of his skill and success in directing such expenditures. The responsibility of the disbursing officer is confined to being able to produce either the cash or properly approved vouchers therefor when his accounts are audited. The managing officers of the corporation which he serves are responsible to their principal or principals for their wisdom and discretion in ordering or approving the disbursements.

The Governmental audit system, on the contrary, is based upon the principle of audit after payment. The disbursing officer is responsible for any errors that may have been made, even after the audit of his accounts, which may not be completed until months or even years after the expenditure. The result is that this officer and his subordinates naturally scrutinize most critically every disbursement, *going even to the extent of practically interpreting the spirit of the legislation authorizing the expenditure.* It is evident that a multitude of questions will necessarily arise in the conduct of a large constructive work that seemingly must be decided by those responsible for its execution, and that the work will inevitably be delayed and hindered if their authority and right of action is continually called in question by the disbursing officers of another department, who are independently responsible and have no interest in the final result produced. The outcome infallibly will be that the discretion, the foresight, and even the constructive ability of the nominally responsible chief are in great measure reduced to the calibre of department clerks.

During my connection with the Panama Canal, interference of this kind exercised by the young disbursing officer of the Panama Canal, who held the rank of a lieutenant in the Navy, was a constant source of delay and annoyance. While this has been partially rectified by the employment of a civilian as the disbursing officer, these fundamental conditions have not materially changed, and after that officer has had his accounts finally audited by the Treasury Department officials, and some of his payments disapproved and charged against him or his bondsmen, the probabilities are that his apparent efficiency will not be of any higher order than that given by the regular Commission disbursing officers.

A few examples may be interesting in illustrating the Governmental way of not doing things:—

I endeavored to encourage the importation of labor to the Isthmus from the surrounding islands of the West Indies, and sent out agents to various points to secure and forward to Colon such labor as could be secured. The payment of the initial transportation charges by the Government was an absolute necessity. Under the Treasury Department regulations, money could not be advanced to these agents to pay their own personal expenses, let alone the transportation bills. I was at first informed that the only way this could be done would be to procure a receipt from a steamship captain for the transportation, and that I, as chief engineer, and my subordinates, would have to certify to the number of laborers that had actually been received into the Government service, and so arrange that the amount of money advanced for transportation should be deducted from the laborer's pay. As these laborers were irresponsible negroes, and could not be compelled to go to work after reaching Colon by any legal method or moral influence, the impracticability of this requirement is evident. It was, of course, necessary to have an extensive correspondence and discussion of this question, which consumed many weeks; and even the delay in getting the vouchers properly signed and approved required so much time that frequently the steamships or sailing vessels that brought this labor to Colon were obliged to leave before they could secure payment. This resulted in the masters of the vessels refusing to bring the laborers to the Isthmus, and demanding advance payment at the point of shipment. This, with other impediments to the obtaining of labor, prevented the securing of an efficient force to accomplish, during the dry season of January, February, and March, certain preparatory work which necessarily had to be postponed for another year. Various other instances occurred in my experience, and while these matters are now supposed to be adjusted, other complications will be continually arising which will cause like delays in the future progress of the work. It is perhaps unnecessary to burden this article with further illustrations.

It should be apparent to every thinking man that when the work must be conducted 2,000 miles away from a seat of government, a policy imposing the necessity of referring all important questions to Washington—and submitting them there to men who necessarily cannot be conversant with the conditions on the Isthmus unless they are informed by the parties on the ground—cannot give satisfactory results, no matter how honest or efficient the supervising officials may be. I may perhaps feel too strongly on this point; but my experience at Panama—my occasional contact with Governmental methods reaching back to a service of five years as assistant engineer on river and harbor improvements—has convinced me that attempts to carry on constructive works under the direction of Washington bureaus—especially when the work is large, complicated, and distant from the seat of government—are conducive to extravagance and waste as to both time and money. I am emphatically of the opinion that Governmental functions on the Isthmus should be confined exclusively to a general supervision of the work, and enforcement of such simple ordinances and sanitary regulations as may be necessary to secure the peace, and the health of the community affected by the constructive work.

Various suggestions have been made as to building the canal by contract work, particularly as to dividing the work up into small sections and letting it out to a multitude of contractors. Such a plan would raise up a multitude of more or less antagonistic, or at least jealous, interests, leading to endless confusion and little, if any, gain in efficiency over the present methods. The situation at Panama is peculiar. If it were simply a canal to be constructed through a comparatively flat country where the excavated material might be thrown on the banks, the small-contract system could be adopted; but the case is totally different. The crux of the work is the Culebra cut, which, in the case of the high-level canal, will be from five to eight miles long, and this work would necessarily have to be under one contractor. The Panama Railroad and the machine shops would have to be subject to that contractor's control, as the material in some cases will require transportation the entire distance across the Isthmus. The question of control of the commissary, the rate of wages paid by the sub-contractors and a host of other details, make it necessary, to my mind, for a single contracting organization to control the entire work.

The fewer the specifications, the more simply they can be drawn, and the larger the amount of authority which can be left to the contractor and his engineers in designing and executing the details of the work, the less will be the cost and the shorter the time for completion. While the tendency will be to make the specifications most elaborate and to place the work, even to its details, under the close supervision of men employed directly by the Government, the best results will be obtained if the authorities in control of the undertaking can guard against the bad effects of this tendency. I firmly believe that if the work is thus contracted for, a sea-level canal can be constructed in as short a time, and for as small a cost, as in the case of a high-level canal built immediately by the Government, with hired labor under the direct supervision of its agents and as the work is now organized.

Originally the problem at Panama seemed to be one of engineering, and the lack of well authenticated data and the inaccessibility of the situation, due to distance and climatic conditions, naturally caused the engineering profession (on account of the interest always taken in a projected public work of an important character) to advance all sorts of theories, to suggest multitudinous plans, and to conjure up difficulties of immense proportions in the carrying out of the other plans or ideas suggested by professional rivals. The data collected and the examinations made by the French engineers, and the investigations carried out under American control, have dispelled the mysteries surrounding the geological formation of the Isthmus; and the problems of the control of the Chagres and of the diversion of the streams interfering with or paralleling the line of the Canal, with the subordinate engineering problems involved, have been found capable of very practical solution. The engineering aspects now excite interest only on account of their comparative magnitude. The removal of material from the Culebra section is simply the same as if it were a railway cut on an immense scale; but the problem is not one so much of excavation as of the transportation and disposal of the spoil, and of so organizing the work as to permit the maximum number of excavating machines to be employed simultaneously and to be continually fed with car equipment, in order that the maximum efficiency per unit can be maintained. It is, in short, a railway engineering problem.

Now that we see light as to the solution of the engineering questions, the proposition is one of administration. The whole subject is rapidly changing from an engineering to a political phase, and there is a tendency towards delay, unnecessary expense, and possibly scandal, due to the political environment. Careful consideration should be given the prevention, elimination, or modification of these dangers, so that this great work may be accomplished speedily and efficiently, and without the scandal and damage to reputations which seem so far to have been associated with the enterprise.

By politics I do not mean the attempt of men of influence in the political field to secure positions for adherents. As a matter of fact, during my connection with the work I saw nothing of the kind. I never had a request from a Senator or Congressman to make a place for a protégé. In any case, this can be guarded against in a large measure, by civil service rules and proper adminstrative methods. I am using the term "politics" in another sense. For instance, there might be questions of "public policy," which would influence us to sacrifice results in order to secure an early completion of the enterprise by the adoption of an inferior plan. It is to be borne in mind that the general business interests of the country are liable to watch every movement made by the Government in connection with the work, to see that no steps are taken that are adverse to American interests; but this tendency may go farther and lead to strenuous effort for precedence in favor among the larger private interests. This is particularly likely to be the case, as the men representing these large interests have more or less political influence or have the ear of the Administration at Washington at any and all times.

An example of this might be cited in the pressure brought to bear on the Administration to confine the purchase of supplies to the

United States, which prevented the purchase of steamships suitable for the business in foreign markets and confined these purchases to a narrowed field, with less competition and hence higher prices, in order to favor American bottoms. Another factor which might be cited is the application and enforcement of the eight-hour law. This question, which might be called a purely political one in a sense, has already been settled in a way that will increase the expense and delay the work. Again, the engineer in charge might make requisitions for machinery of a particular manufacture, with the efficiency of which he is thoroughly familiar; and the supply of the much needed apparatus might be delayed, owing to the fact that some rival desired to secure the introduction of his machinery—which he would claim, and doubtless believe, to be equally efficient. This new would-be seller might find it necessary to secure what he might call "proper recognition" through the services of influential business connections, or possibly members of Congress or Senators from his State or sections of the country, to assist him in getting a hearing through influential members of the Administration. Such a course would undoubtedly seem proper to him; but it would all result in confusion and delay, and in the possibility of the person in responsible charge of the work being eventually required to use machinery or appliances with which he was unfamiliar, and with the efficiency of which he would not be thoroughly satisfied until after time had been consumed in investigations or experimental use. An example of this might be cited in fact that the late chief engineer, and the present one, were practically satisfied in their own minds that the material from the Culebra excavation could be most efficiently handled by loading it on flat cars of large capacity, plowing it off, and spreading it out by machinery with which they both had had a wide experience and were perfectly familiar. This led the late chief engineer in the autumn of 1904 to recommend the rejection of all the bids which had been received for various dump cars. The pressure, however, brought to bear upon the Commission and the engineer resulted in experimental orders being given for four or five different cars, so that their relative efficiency could be demonstrated by active practice. Or, I might cite the conflicting interests of the producers of the various kinds of fuel, involving in turn the selection of power plant and machinery—whether coal, oil, or the utilization of electricity to be generated from the water power made available through the construction of dams.

As the business interests which would be benefited by the final result are necessarily powerful and capable of commanding the services of influential men to advocate their claims, and this influence can be brought to bear upon the various officials situated in Washington—Canal Commissioners, Chairmen, Secretaries, the President, or even of Congress itself—and upon public opinion moulded by the press—and ultimately, through these sources, either singly or combined, upon the responsible person in charge of the work on the Isthmus—the ultimate result can be easily imagined. It is as true today as it was in biblical times that "wheresoever the carcass is, there will the eagles be gathered together."

How widely different would be the result if a private interest were charged with the responsibility of this undertaking, or if it were possible, either directly or indirectly, to place this work in the hands of one man, who would be subjected to no influence except the desire for a speedy and economical completion of the great work, and he alone could finally decide as to the best course to pursue and as to the best means to adopt, either in the employment of men or of machinery, influenced by no motive except economical efficiency! It is evident that this duty cannot be satisfactorily performed by any official of the United States Government, no matter how high or how low, whose tenure of office is affected, directly or indirectly, by popular suffrage, or who might find it to his interest to placate the members of Congress, the press, or powerful influences, in order to favor other public measures in which he may be interested, either as a statesman or a politician.

During the year I had charge of the work on the Isthmus, I endeavored to conduct operations so that the work of preparation, providing for the employing of men, and the experimental studies of construction, should go forward evenly balanced hand in hand. My feeling was that the work should be conducted in such a way as to develop the efficiency of the machinery then on the Isthmus (as compared with that of the American machinery which would be gradually installed) so that data could be established of the relative performance of the men and appliances, the effect of climatic conditions, the value of various forms of labor, the cost of handling various classes of material, and the use of different methods—training and discipline of the working force being concurrently built up as one of the consequences. I realized fully that the actual costs themselves were valuable only in the light of most careful consideration of the various factors contributing to form the conditions under which the work had been carried forward. While this system of costs may have been in a measure crude, it was at least based on what might be considered proper principles; and as men employed on work of this character must be taught proper methods not only by precept but by examples in practical application, I considered the work a training school, the results of which would ultimately justify the course pursued. The principal object was to establish a system of unit costs, so as to arrive at some unit of measured efficiency which could be applied to every function of the work, and by which the relative efficiency, in dollars and cents, of measures, men, and methods could be determined. The system established was such that the unit of measure of efficiency was the cost per cubic yard of mining, excavating, transportation, track maintenance, disposal and disposition of material. The relative expense of the utilization of the various spoil grounds established by the French could thus be easily determined.

The relative cost per cubic-yard haul down-grade to low dumps, with frequent changes, could be compared with short-distance hauls up-grade to existing French dumping grounds. In this connection, it should be borne in mind that the cost per cubic yard per mile haul of material after loading and unloading was an infinitesimally small quantity as compared with the expense of loading and unloading—that is, the cost of each added mile haul after a train is once moving under speed is extremely small. An analysis of the costs as thus separated and tabulated also showed the effect of climatic conditions on labor, and all of the various elements that entered into the work. From this, I considered, conclusions could be arrived at that would very materially assist contractors in determining a reasonable price for which the remainder of the work might be done. The mere cost of the work itself, in any one class of material and handled by any special method in any one month, would not be of itself a determining factor in the light of conditions which surrounded the work; yet taking the year round, it would, in my opinion, furnish the basis of data which would enable a more intelligent approximation of the cost than if such data had not been kept, or the work had not been carried on along these lines.

The ultimate conclusion which was arrived at—and this was not the result of merely professional ideas, but of careful consideration of all the conditions at the close of my year's experience—is that under all the conditions surrounding the undertaking only two courses remain to be pursued. Either the work should be put into the hands of one strong man, with practically unlimited authority, combining the technical and scientific training of the engineer with the administrative and executive ability of a man of force; with this should be coupled the separation of all matters connected with this work from the control of the ordinary Government departments at Washington—but under such supervision only as to insure the Government that his administration is efficient; or the same result should be accomplished through the letting of the work to a contracting firm, large enough to control under one management the entire constructive work on the Isthmus, under broad and general specifications and under such general supervision as may appear to Congress to be proper. The first step of any contracting firm would then be to place its affairs in the hands of a strong single executive, supported by such advisory technical knowledge as might be deemed necessary. The precedent for this method, and a working application of this principle, is the special agreement which was made for the construction for the improvements at the mouth of the Mississippi under Capt. Eads. It was a contract which bound the contractor to nothing but certain results for a certain sum, and no more satisfactory compact for public work was ever made by the United States.

I feel that only in this way, or some substantially identical way, can the construction of the Canal be successfully accomplished. While the work may be completed at some time, and at some cost, by the poorest and most inefficient method—even by hired labor under Government control—the accomplishment will be far from satisfactory. It goes without saying that if any large American corporation were engaged in the business of constructing a great public work for the purpose of furnishing transportation, unhampered by political questions or public opinion, the work would attract practically no attention, except the ordinary interest connected with an engineering project of great magnitude. It is a fact of which the public is not aware that many of the large railway systems today are spending as much money annually, in the improvement and operation of lines of transportation providing for the handling of tonnage much greater than that will pass through the Panama Canal, as will be expended on the Panama Canal, and their operations proceed with hardly a newspaper notice. While employed as the general manager of the lines of the Illinois Central Railroad, I was responsible for the expenditure of more money per annum, and had more employees engaged in it, than would ever be spent and ever be employed on the Panama Canal in any one year.

It may be argued that commercial interests would suffer by placing the Panama Railroad under the control of a general contractor, and that it will be difficult to secure the proper direction of its obligations as a common carrier. The result of the operations during the last year would indicate that it would be difficult for any contractor to produce more *un*satisfactory results.

The plan suggested in my official communications on this subject was that of operating the Panama Railroad as a simple transfer organization, whose sole duty as a common carrier would be to receive the freight delivered at its ocean wharf on one side, and deliver it at the ship dock on the other side, for a flat rate per ton—regardless of the classification, except so far as the cubical contents of certain light articles would be made equivalent to a ton. The proposal is simple and perfectly practicable. The forwarding agents of the world would thereafter bill all goods over transportation lines using the Panama Railroad as an immediate transferring link on their bills of lading, subject to the transfer charge across the Isthmus of Panama; this could be collected by Government agents, either from the steamship line delivering the freight or the one receiving it. In this way no complication of accounts would be necessary, and all commercial interests would be treated with equal fairness. It would be a simple, normal, and logical introduction to the conditions which will exist when the canal is opened, and rail trans-shipment gives way to through passage of shipping under a tonnage charge. One of the most strenuous objections raised to the proposition was that "it would unsettle Transcontinental rates." If this is to be a final and determining reason—why are we building the Panama Canal?

After the proper facilities have been provided in the way of docks and wharfs, double-tracking of the Panama Railroad, and providing it with modern equipment, as outlined by me when in charge of the work on the Isthmus, there will be no difficulty in a general contractor easily, promptly, and economically handling all the commercial freight, without any interference with the Canal construction work; particularly if he has the absolute control of both, and is held accountable only for the proper performance of the duties of a common carrier, and is not subjected to trivial interference.

The questions of local rates and the charges to be made for this service by the contractor are simple, and easily adjusted; it would seem a brilliant opportunity for the United States Government, either through its Interstate Commerce Commission or otherwise, to experiment with the regulations of rates across the Isthmus and the general control of the operation of the Panama Railroad, and acquire some experience therein before attempting to tackle the complicated problem of regulating the rates and controlling the methods of doing business on the 200,000 miles of railway which interlace and ramify throughout the United States. The transportation-rate problems of Panama, as compared with those of the United States as a whole, might be likened a single grain of sand compared with the whole seashore.

Presumably the reader will recognize the fact that many men in advanced years have looked back on the simple Utopian ideas of their youth with a smile, after they have come in contact with the cold, practical world. When any man, no matter what his age, arrives at a condition in life when he is beyond or above errors, does not make them, or making them is not able to recognize that they are errors, and is not strong or intelligent enough to admit that they are errors—it is time for him to depart to another planet, where he can either find something to learn or be employed in a larger field of usefulness.

If the experience had not been so serious, I should look back to my first connection with this enterprise and the experience gained therewith, and smile to think I had been so innocent as to suppose myself able to overcome the long-settled influences heretofore indicated, or to impress my individuality upon the work or employ in it the methods with which I had been familiar for years. The usefulness of any man who might be called in as an engineer of demonstrated capacity to supervise an enterprise of this character is naturally measured by the extent to which he may be permitted to use his own methods and make avilable the result of his past experience. To expect that any person who is really qualified to conduct the work will radically change his methods, which have been the outcome of a lifetime of experience, and adapt himself to moss-grown Government methods, is to expect the impossible. It demands that a man should be content to ignore the instincts of his profession, and to subject himself to the various influences brought to bear upon him, drifting along in a perfunctory way, satisfied to draw his compensation, hoping that in some way or other he may be able eventually to see the work completed, or wasting the best years of his life in the partial accomplishment of it.

The writer desires to take this opportunity to state most emphatically to his professional brethren that his resignation from the position of Chief Engineer was not the result of any desire to better his financial condition. No financial consideration would have induced him to lay down this work if, on sober reflection, he could have been convinced that he could accomplish desirable results and that it was his duty to remain. On the other hand, under conditions as they existed, no compensation to his mind would have justified him in continuing to hold the position. During his year's connection with the work he had, from time to time, to put up with, to condone, and to concur in many things which under ordinary circumstances of professional employment he would not have tolerated or submitted to; and no one can censure him as much as he censures himself to think that he fell into the error of accepting conditions which later matured reflection persuaded him were unwise. During his last voyage to Colon, after six days of uninterrupted thought which the sea voyage made possible, he gradually saw when he was drifting and felt the best interests of the work demanded his retirement and the selection of a successor who would be able and willing to subordinate himself thoroughly to the authority of those above and to the influences which, so far as the writer could see, must dominate the conduct of the office. It was apparent, however, that a resignation in which these reasons were set forth might have an injurious effect upon the project and might possibly embarrass those charged with its consummation.

If the events which have followed in the train of the writer's resignation have caused public attention to be drawn towards the situation surrounding this great undertaking, and shall lead even indirectly to its proper demonstration and conduct, the writer will be content, even at the cost of the apparent misconstruction of his motives and of the attacks that have been made upon his reputation. He desires to add, however, that he had not accepted another position prior to his interview with the Secretary of War, and had declined to consider such a proposition except under the conditions that it should be subject to the rendering of all essential service to the Administration, and to the arrangement of a disconnection from the canal work at such time and in such a way as to cause no undue injury to the project or annoyance to the Administration.—*J. F. W.*

THE AMERICAN, AND THE GERMAN, "PERIL."

By Louis J. Magee.

III. AMERICAN TRADE METHODS TESTED BY GERMAN EXPERIENCE.

Mr. Magee's articles have already attracted wide attention, and drawn from able critics the expression that they furnish the best interpretation yet offered of the industrial systems of the United States and of Germany, and the meaning these have for each other and for their rivals in manufacture and commerce.

Particular point is given to their appearance at this time by the menace of a tariff "war" between Germany and America, and by the suggestions wakened through Mr. James J. Hill's recent warning to his countrymen that they are squandering their natural resources without working up markets for their manufactures. The present paper, dealing directly with the question of export trade, its place in the National economy, and the value of foresight in its cultivation, is peculiarly apposite to the times.—The Editors.

A VERY strong national trait with Americans is our infinite trust in the efficiency of a sudden spurt; our confidence in extraordinary effort at critical moments. The German method, whether it may be better or worse, is quite contrary to this. The German organizes always for sustained effort. In Germany the study goes on long before the question becomes acute, and it does not then become necessary for uninformed persons to take up a new subject and apply all their efforts to it for the moment.

There are a great many matters connected with business and industries which cannot be settled quickly; among them are not only the solutions of technical problems, but also many matters connected with internal organization, sales, treatment of customers, and all that makes for tradition and custom in trade, and especially the questions connected with the treatment of employees. Some of the larger German firms have departments devoted to what they call *Wohlfahrt.* One of the members of the *Directorium* of Krupp, for instance, handles all questions referring to social problems and anything that is done in the interest of the employee. The interest of this department in these problems is perennial, and those who have this department in charge become expert authorities on their subject, just as other members of the directorate are experts on the subject of guns, armor-plate, or finance.

No matter what brilliant examples we may show to the contrary, we have yet to learn as a nation that the bright, shrewd man may most utterly fail in such situations, and the slow, well-informed man must come in and do the work. We should not put too much upon any one important man, but so organize as to have expert colleagues whose knowledge can supplement and complete our own. The names of officers in German companies appear neither in the advertisements nor on the letter heads. Correspondence is almost exclusively in the name of the firm. All transactions and discussions are scrupulously recorded. Everything is planned on the principle that the corporation is greater than the man.

One of the hardest things for an American firm, which has been very successful at home, to appreciate, is that it must make concessions to foreign customs and ways of thinking, if it would do business abroad. We do not deserve so much credit for the cotton, the grain, and the petroleum which we export; Europe would purchase these articles from us, in any case. Every sale, however, of manufactured goods which we make is a greater credit to our intelligence and energy, and, in some lines, a credit to our tact and thoroughness.

Now as to some of our weak points in American practice as they appear to those used to European methods of doing foreign business.

It is very difficult to get concise information regarding American products in such a shape that it may be intelligently used at a great distance from the base of supplies. Much of our most excellent manufacturing and engineering home business has been built up by agents who were in close touch with the chief officers, and by officers in close touch with the factories. The agent has frequently been, and is still, in some cases, ignorant as to important details, and his chief business seems to be to find out the relative importance of the customer and the probability of his immediately placing an order. If the customer asks searching questions, the agent has to get the information from the technical staff. It is very likely creditable to the American business man that inquiries are followed up pretty generally with personal visits. It would seem, however, that agents often think that they are helping the business and entertaining the prospective customer by making abnormally long visits and volunteering a great deal of *verbal* information. This method is for the complex industrial life today becoming antiquated and provincial. It is the engineer's province to inform himself as to the tools and materials which can be used to accomplish the ends before him. Therefore, the descriptions and price lists cannot be considered just whenever the agent happens to hand them in, but should be so concise that they require no discussion whatever, and will speak for themselves when the time comes for decision regarding them.

Many American manufacturers have an absurd idea that they will suffer harm if they print prices in their catalogues. This practice is very irritating, as so much time is wasted in getting at the prices, and the prices are so frequently given "with hems and haws." If a firm has an article which can stand competition, and makes a list price which shall be subject to moderate discounts such as are customary in international traffic, it may be fairly assumed that the widely distributed prices will do much more good than harm. There are many thousands of careful readers throughout the world studying your advertisements and your circulars, and some of these will place orders, through their correspondents at home, if your literature puts them in a position to do so with a certain degree of intelligence. An engineer may have upon his desk your circular explaining the many advantages of your oil, your belting, your engines; but if you have not told him the prices, he can come to no decision through your other claims, and he is likely to purchase from some firm which gives, without the asking, the information he requires. Any close observer of advertising methods must notice that as technical enlightenment increases and as the people in general read more about scientific progress, the trade advertisements that help most are those which contain basal facts.

In short, the German industries show a tendency to be instructive in their advertisements and to be very explicit and complete in their circulars. A good rule for every American manufacturer who hopes to have his goods sell beyond the limits of his own ken, is to describe those goods in all essential features in exactly the way he would want them described to him if he had never seen them and were forced to decide upon their use, and incorporate them in his work, in Madagascar or Chili.

American printed matter is excellent; the paper and type is good, and the artistic covers usually in much better taste than those produced by the old art countries of Europe. These delicate and sometimes very beautiful catalogues have undoubtedly an advertising value, but a luxurious picture book does not satisfy the distant engineer who is getting together a large plant from many elements. He would much prefer half a dozen pages of dimension diagrams, and tables of prices, capacities, efficiencies, etc. It is a fair question for every manufacturer to put to himself: "Do you think that you can ultimately fool the technical public?" if not, tell them beforehand all that they could probably under proper conditions of operation and use find out for themselves."

If your product is as good and cheap as that of your foreign competitor, and your agent as tactful as his, then your success will depend largely upon your guarantee and your specific statements, the explicitness of your tender, and the clearness of your descriptions. European purchasers are accustomed to figure closely on efficiency and depreciation. The average American has a tendency to evade these subjects. Frequently the cause is that the purchasing public here has in the past been very lax in imposing conditions. The cleverness of agents has sufficed to furnish enough information both for the purchaser and the furnisher. This condition seems to be rapidly changing, but obtaining information from some manufacturers in this country is still like the operation of extracting teeth.

Another point in the export business in which some of our American firms could take lessons from Europe, is the subject of payments in general. A great deal has been written about our harshness in demanding payment against bill of lading; that comes from our ignorance of foreign conditions and the fact that many of our firms which produce articles adapted for export, are satisfied with their success at home and personally disinclined to interest themselves in foreign conditions. The Germans are in much closer contact with the remote countries, partly through the export houses of Hamburg and Bremen, and partly through the rapidly multiplying bank connections with foreign countries; this same is also true of England. Aside, however, from the question of cash payments—which are very good as long as you can get them—some of our firms seem to be rather arbitrary as to the changes in prices. The necessity of holding a tender open until it could reach the person it was intended for outside of this country, seemed recently to be an entirely new thought to the agent of one of our largest firms.

Practically all German observers have dwelt emphatically on the wisdom of the American tendency to specialize on certain types. Perhaps in the general acceptance of this doctrine we have sometimes gone too far. There are many wants in the world which cannot be met with normal existing types, but, in spite of that, offer a basis for profitable business. There may perhaps be a golden mean between the almost dictatorial offering of a normal type which has made many a firm successful, and the willingness to build whatever a customer wants, which has not entirely hindered the development of European industry.

There are many people abroad who would like to use your product, if you would meet them half-way. Europe, because of its own industrial progress, its own advanced enlightenment, and its own complex needs, must always be looked upon as customer as well as competitor; we never shall get along without Europe. I feel certain that many of the export sales of which we are so proud, are due to the intelligence of the Europeans in finding out what good things we had, rather than to our own commercial activity in bringing about the sale.

An enterprising German manufacturer found a novel machine tool in the United States, and took the selling agency for it abroad. It now appears that he has, to the astonishment of the American maker, sold more of these machines in Europe than have been sold in the United States. A New York exporter remarked casually that he had, within the last five months, shipped one hundred car-loads of *high-grade* machine tools to the Continent. All of these were sold through an agency of Germans with headquarters in Berlin. These good Continental *customers* were at the same time, he said, proving invincible *competitors* on other types of tools, in South America.

We should never be blinded by the wholesale figures of our exports. After subtracting the raw products like wheat, cotton, petroleum and metal, we might go further, if we knew all the circumstances, and subtract some manufactured articles which, through peculiar circumstances, have found a large market abroad. Industrial America, on the whole, can be proud of its export business only when every factory can, with profit, place a certain percentage of its output in the foreign market. The important conditions upon which this result depends are, first of all, good quality of the product for the price asked; second, efficiency in selling organization; third, promptness and constancy in delivery; fourth, exact and prompt methods in correspondence; fifth, far-reaching and reliable financial connections.

American firms should do more to facilitate the use of foreign languages in their offices and publications. This has long been the theme of consular reports, but we are not yet sufficiently cosmopolitan in this respect. Our inevitable change to the metric system of measurements can of course not take place without some throes, but the longer we postpone it the harder it will be.

If I were making a suggestion to American firms who have not yet attempted to export much, or have not yet succeeded, I would say that our chief shortcoming in comparison with English and German firms is wont to be our lack of real knowledge of the market. We are liable to be superficial in dealing with foreign situations, inasmuch as most of the leading men in our country are occupied with a complexity of affairs which goes quite beyond their own official business. Many such leave their export business to people who have not sufficient power to act aggressively.

In all their business successes the Germans are (with the exception of some bigoted beaureaucrats) seldom conceited. In contact with English and Americans they are conscious that they are often disliked and misunderstood. They even criticise themselves sometimes as being unintentionally austere, narrow-minded, insistent in small things. But they have learned frugality in a long struggle. Their honesty is proverbial and deserves to be. Germans too often hide splendid talents beneath an unprepossessing exterior. They have this to fight against in international intercourse; but as a rule they have only to be known to be appreciated. They are, in a high degree, objective, thoughtful, pholosophic. These qualities make for the rule of right and reason. The class more especially identified with the nation's recent commercial activity, namely the merchants, captains of industry, financiers, business lawyers, leading technical and other professional men, are, as a rule, precisely informed, unostentatious in bearing, quiet and forceful in address, tireless, devoted workers, fruitful thinkers, and often masterful in combination.

After fifteen years spent in their midst, I am convinced that they are more liberal and kindly, more straightforward and reasonable in their demands, than the outside world at large believes them to be.

Urging to greater effort within their borders, the Emperor gave his people the noble motto: "Limited toward the outer world; unlimited within." It is, indeed, this vast possiblity of development of German culture, skill, and efficiency *at home;* this infinite refinement of quality; this gradual increase of forces through studied organization, which will more and more engage the attention of the world. But even across this brilliant prospect lies the cloud-shadow of agrarian opposition.

We all have our weak points, and the oft announced "peril" does not seem imminent on either side. We have not invaded the world's markets in any such way as to alarm the strongest elements in Germany. Our natural resources, combined with our peculiar national forces, constitute a power which, directed in a certain way, might bring about the struggle of the ages. Germany—clever, thorough, virile—lacks our resources. As a compensation, Germany has gotten down to a recognition of fundamental truths in a good many matters where we are still groping. If we were to exchange territory with the Germans, each people taking along all their own institutions, their government, their methods, America would perhaps in some respects become a still greater danger than it is today. I believe the two nations are going to understand each other better, and "get together" in many future situations.

Mommsen, in his last public statement, said:

> "All State government consists in the compensating of opposing interests; in the bringing about of such conditions that the rival tendencies are made to agree tolerably; no party having fully its own way, and the community being balanced."

This applies to the realm of world trade as well as to home government. Constrained by their own troubles and by their ultimate appreciation of each other's strength, the great industrial rivals ought, indeed, to "agree tolerably."

THE SQUARE DEAL IN WORKS MANAGEMENT.

By O. M. Becker.

III. WHAT CAN BE DONE WITH THE WORKERS.

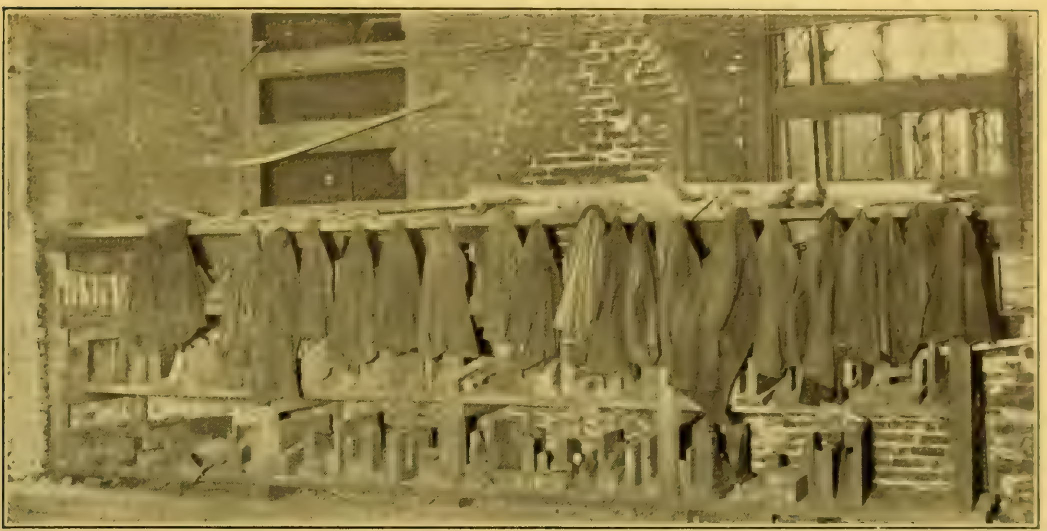
Mr. Becker's series began in the issue of this Magazine for January last; the first portion dealt with the "common-sense of the management of men," and the second with adaptations suggested by modern ideas concerning chiefly the design, arrangement, or structure of the shop itself. The various phases of "welfare work" are necessarily interwoven and overlapping, but the present installment of the discussion takes up shop institutions which have to do more particularly with still later conceptions of the economy of fostering and conserving the physical energy of the employee.—The Editors.

THOUGH the expediency of elaborate shop fixtures and equipment may be open to some question, there can be none as to the expediency or even obligation to provide simple sanitary appliances (and facilities for their use) for preserving a degree of cleanliness and for conserving the decencies. The lavatory arrangement very properly is supplemented by suitable arrangements for taking care of the street garments and personal belongings of the workers. Except possibly in case of those rare occupations where absolute cleanliness prevails from the nature of the work itself, the working girl wears better clothes on the street than at her work. Even in the exceptional case there are occasions and seasons when outer garments are necessary, and must be taken care of during the work day. The manager could have but little regard for decency and womanly modesty who would decline to give his women employees so much as a little corner wherein the change of garments could be made in privacy. It seems almost beyond belief that in these days women employees should be obliged to make any such necessary change of clothing in the presence of men; but that there are such instances is as certain as it is incredible. Unless his establishment is small or of recent construction many a manager might find to his surprise, did he make an inspection tour at a suitable hour, the shop garments of women and men indiscriminately strewn about a dirty floor just where they had been stripped off in some of the shops, as did a certain superintendent well-known to the writer. It is not at all surprising that under these circumstances, or any at all approximating them, modest women should refuse to remain in such places, and that vice should thrive. The charge sometimes still heard that certain factories are little short of brothels is all too often founded upon too much fact; and the responsibility for such conditions is wholly or very largely upon the shoulders of the short-sighted management which has more regard for a dollar than for a woman's modesty.

It would seem therefore that a dressing room, where women employees may have some privacy, is one of the essential requirements of a decently managed factory using work people of both sexes. And if there is a responsibility in providing these for women, why not also for men? Whatever answer may be made to this question, it is surely open to no doubt that a workman has a right to go home with clean clothes, as well as clean face and hands. Obliged to hang his hat and coat to a nail in the wall, to catch the dust and grime of the shop, as is yet very commonly the case, there can be little incentive to personal cleanliness and neatness in other things.

Apparently the least that can in reason be done by an employer is to furnish inexpensive wooden cabinets along the walls of the shop. If there is a wash room or changing room, of course the cabinets or lockers will be better placed there. In some instances racks and hooks alone may be found sufficient for use in a dressing room. Such an arrangement has the disadvantage of affording no privacy, no place for leaving personal belongings that cannot be hung up, and of offering temptation to the dishonestly disposed. Wooden lockers or closets may be the best arrangement, if it is found necessary to have them along the walls of the dusty shop—though indeed it would seem that sufficient space could always be found for a small locker and dressing room, even in crowded shops. Such cabinets are not very sanitary, however, being hard to clean and lacking ventilation. When not exposed to dust and smoke, they can be provided with openings for air circulation. Undoubtedly the best arrangement is that wherein expanded-metal lockers are ranged about a well ventilated room used also as a lavatory and sanitary closet room, or at all events connected with them. The circulation of air about the room will ordinarily be sufficient to aerate the lockers and contents sufficiently to prevent staleness. A steam pipe run along the bottoms of these lockers conduces greatly to their sanitation.

Along with lavatories, lockers, and dressing conveniences, and even more essential than these, go decent sanitary and toilet conveniences. Unfortunately there are still many places where such conveniences are absolutely lacking; and there are many more where they are amazingly crude and consequently also disgustingly filthy and



THE OLD WAY—AND STILL THE VERY COMMON WAY.
The interior of one of the largest American forge shops. Badly lighted, ventilation far from good, and not a locker or wash basin.

unsanitary, as well as positively immoral. This condition is all the more shocking when it occurs in connection with work rooms wherein both sexes are employed, as is not infrequently the case. What could be expected of the *morale* of a mixed working force using indiscriminately the same filthy toilet and wash basins, if any are provided?

A METHOD IN USE IN AN ENGLISH FACTORY EMPLOYING MANY GIRLS.
Large, airy room, for hanging street garments. The lack of lockers indicates confidence in the honesty of the employees. Cadbury Bros. Cocoa Works, Bourneville.

VIEW OF THE WARDROBE, BATH AND WASH-ROOM FACILITIES IN A LEADING MACHINE-TOOL WORKS.

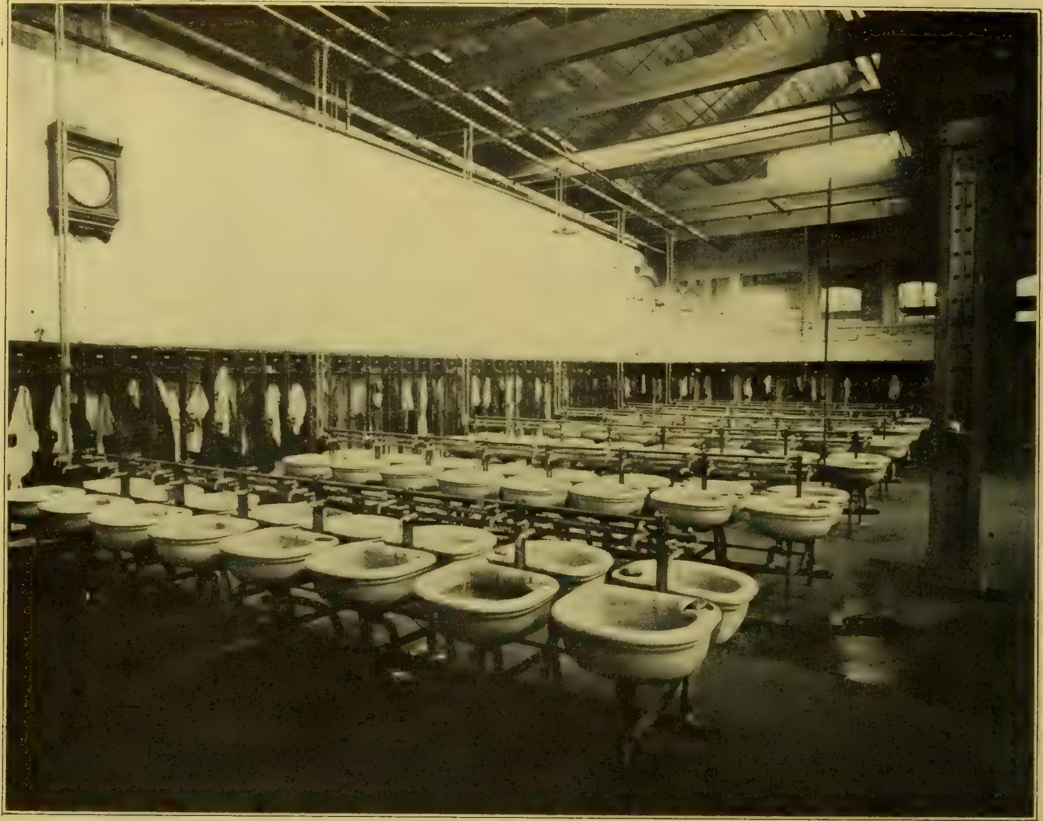
The upper picture shows an equipment of Mott lavatories and steam heated racks for hanging and drying street clothing. The lower view shows the wardrobe and baths connected with the foundry. The door of one of the baths is open, showing the tub and hot and cold water supply. The Brown & Sharpe Mfg. Co., Providence, R. I.

Can anything less be required than separate toilet rooms, clean and decent? In these days of sanitary plumbing, disinfectants, and waste removal it is difficult to conceive a valid reason for the continuance of such disgusting conditions.

A WASH AND DRESSING ROOM FOR FEMALE OPERATIVES
In the H. J. Heinz factories, Pittsburgh, Pa.

The simplest accommodations are usually quite good enough. Indeed, extreme elaborateness is quite likely to be resented. The thing to be insisted upon is cleanness and proper sanitation; and a thing to be emphasized is privacy. The lattter desire can be satisfied at small additional expense. It is perhaps unnecessary to provide individual box closets for the latrines, the semi-private stalls doing very well under some circumstances. The closet is in every respect the more desirable, however. A further requirement is that the toilet be kept clean. The method of installation is therefore of primary importance, and it is desirable that floors and walls be of such material as lend themselves readily to this end.

Anything less than the simplest provision here pointed out smacks strongly of the sweat shop, happily now in its decadence. Fortunate it is for the moral as well as the physical side, that sweat-shop methods, whether in the clothing business, the metal industries, or in whatever trade, are going the way of all impedimenta to industrial civilization. Already the shop wherein there is little evidence of regard for the convenience, physical welfare, and modesty of its work people is regarded with distinct disfavor, as out of step with the forward movement of civilization, a relic of industrial barbarism sooner or later to be eliminated by law if not by the self interest of the responsible ones. The disposition of employers generally to make ample provisions for observing the common decencies is one of the welcome signs of an awakening industrial conscience, and exactly therein lies the beginning and basis of all sane "betterment" or "welfare" activity.



WASH-ROOM AND CLOTHES LOCKERS. ONE OF THE SHOPS OF THE NORWALK IRON WORKS.

The floors are cement, easily washable with a hose. The bowls are large, with large faucets and waste, set low to facilitate washing the face and head, and without flat slab to collect standing water. Designed at Norwalk and since adopted and made by Mott.

The assertion is frequently made that such conveniences as have been mentioned are not appreciated by the work people, and that when supplied they are not much used and are abused. Experience and observation does not bear out the assertion. It conclusively proves the opposite, however. It might of course happen that there would be cases of abuse; but if an effort is made to preserve proper conditions the very force of example compels a fair regard for decency. There is something to appeal to the men and women. The same question came up when the construction of one of the best examples of

EXAMPLES OF WASH-ROOM AND LOCKER INSTALLATIONS.
Above are shown semi-ventilated lockers of the Sherwin-Williams Company's works; below, metal lockers and lavatories in the new shops of the B. F. Sturtevant Co., Hyde Park, Mass.

sane present-day factory building, equipment, and administration was under consideration. The president of the company* made an investigation covering all kinds of conditions of shops and factories and other industrial establishments. He found that without exception, in those places where superior toilet and other accommodations were provided, they were respected and properly used.

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* Mr. Edward Weston, of the Weston Electrical Instrument Co., Newark, N. J.

Nowadays almost every shop or other place wherein people work, is provided, if the building has more than one floor level, with elevators or lifts for transporting materials up and down. Remarkable as it may seem, until recently it had not occurred to any except a very few employers to allow the work people to make use of these same conveniences in reaching and leaving their respective places of work. Usually employees were, and still are, forbidden to use the lifts intended for materials; and where not forbidden to do so, they are able to make litttle use of them because the elevators do not run before the workmen are expected to be at their places and are shut down immediately the quitting whistle blows. The importance of running the elevators a few minutes before and after work begins and ends, a practice involving practically no expense, does not seem to be realized as it should be. Climbing stairs is very fatiguing work, especially for women. After climbing several flights of stairs a girl starts into her day's work handicapped by a fatigue greater than would result from several hours' labor at her regular work—a handicap as unnecessary

A HAPPY MEDIUM IN THE WAY OF WASH-ROOM APPOINTMENTS.

Bowls, plumbing, and closets of approved but comparatively inexpensive pattern, and thoroughly sanitary. Girls' wash room, McCormick Twine Mills, Chicago.

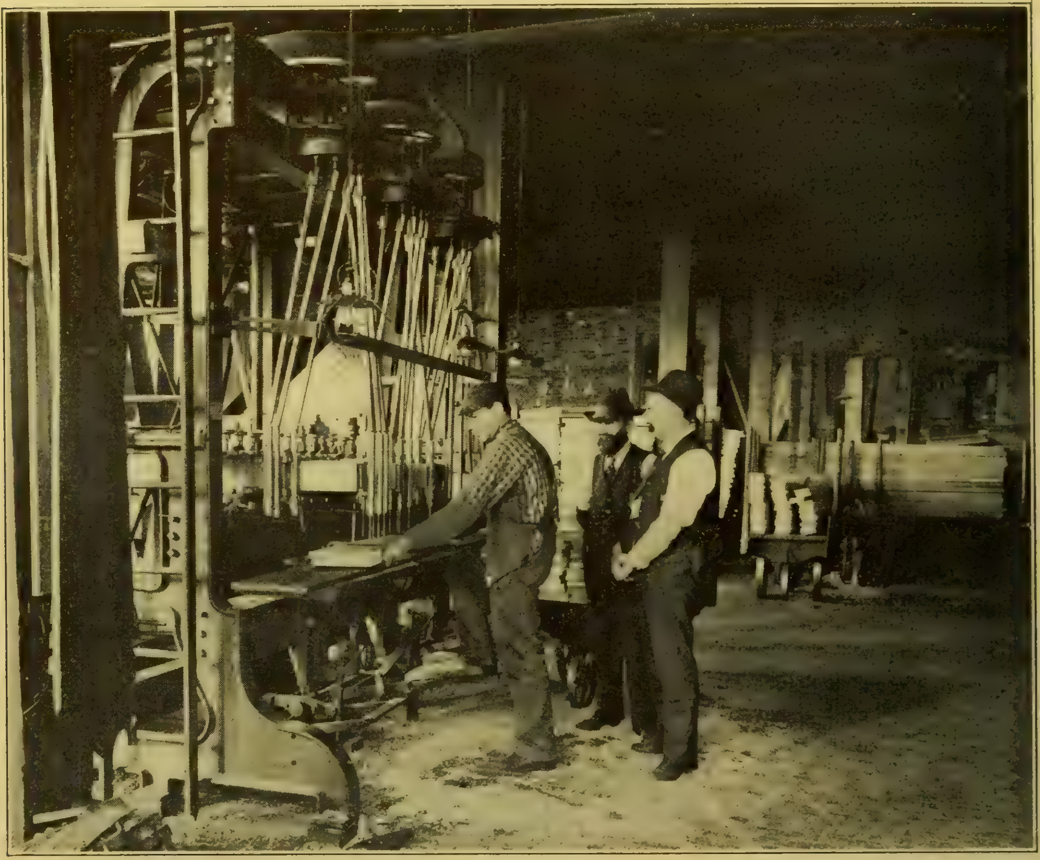
WHICH PARTY WILL ARRIVE BEST FITTED FOR ENERGETIC WORK?

The usual mode of getting to the upper floors of a factory is by climbing several flights of stairs—an effort requiring much of the workers' energy. The elevator, where practicable, certainly adds much to the daily output of workers on the upper floors.

as it is wasteful. The same thing precisely, though possibly in a less degree, is true of men. There is no reason why energy should be wasted in wearying the muscles, even though they be the muscles of work people, when appliances are at hand which could do the work much more economically or when such weariness could be prevented just as easily as not.

Furthermore, it is in many cases necessary for workmen to change floors frequently for one purpose or another. The much climbing of stairs is an unnecesssary drain upon their vitality. If ordinary elevators are not available, and out of the question, there are other expedients that serve the purpose very well. One such, in rather common use in western flour mills and grain warehouses, and now coming into use in factories also, is modeled upon the hod elevator utilized in building construction. An endless chain or belt running vertically through the several floors at a suitable speed, is provided at convenient intervals with projecting rods and shelves or steps. In use, the passenger steps on one of the moving shelves or steps and at the same time grasps a convenient handle, rides to his floor, and steps off again. Such an arrangement obviously might permit accidents, unless well safeguarded. There seems to be no reason why these safeguards cannot be provided. At any rate the device is inexpensive and useful.

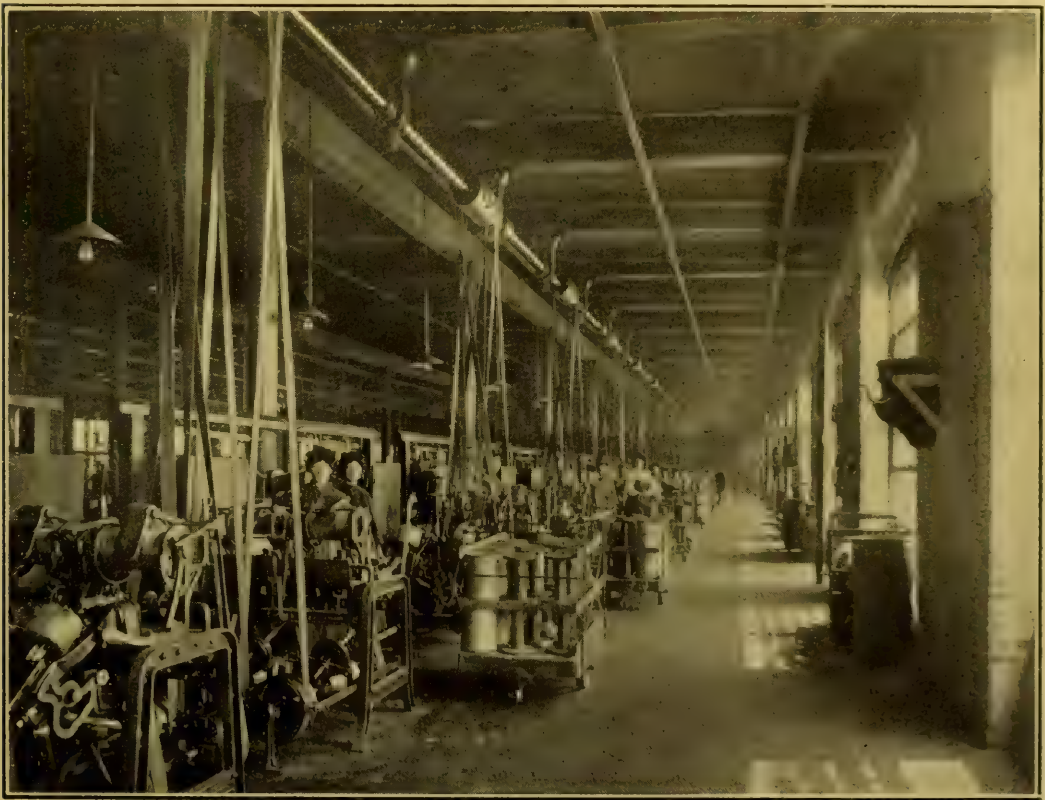
The amount and quality of work turned out depends very largely upon the physical condition of the worker. A sick man accomplishes little, and a tired man cannot do his best. It is therefore of specific economical importance to conserve as much as possible the health and strength of the worker. If he is required to do things in connection with his work that unnecessarily tire him and sap his vitality, the employer loses thereby, and loses needlessly just in proportion as the condition is remediable. Many operations are of such a nature that the operator could sit just as well as stand; and there are very few indeed that do not admit of the worker sitting or otherwise resting at intervals, even if only for a few moments at a time. Possibly some machinery might require, in specific instances, to be re-arranged; but there is nothing inherent in the nature of most jobs that would prevent such a re-arrangement. The clerk in a department store, for instance, might just as well sit as stand while not waiting upon customers or putting stock in order. Often she could with advantage sit while doing her work; and having the opportunity to do so, she will be better-natured and be able to give better service to both customer and employer because not unnecessarily tired and worn out by useless standing. In the factory there is no more reason why a man



A JOB WHERE THE WORKMAN MUST STAND, TO FEED THE MACHINE.

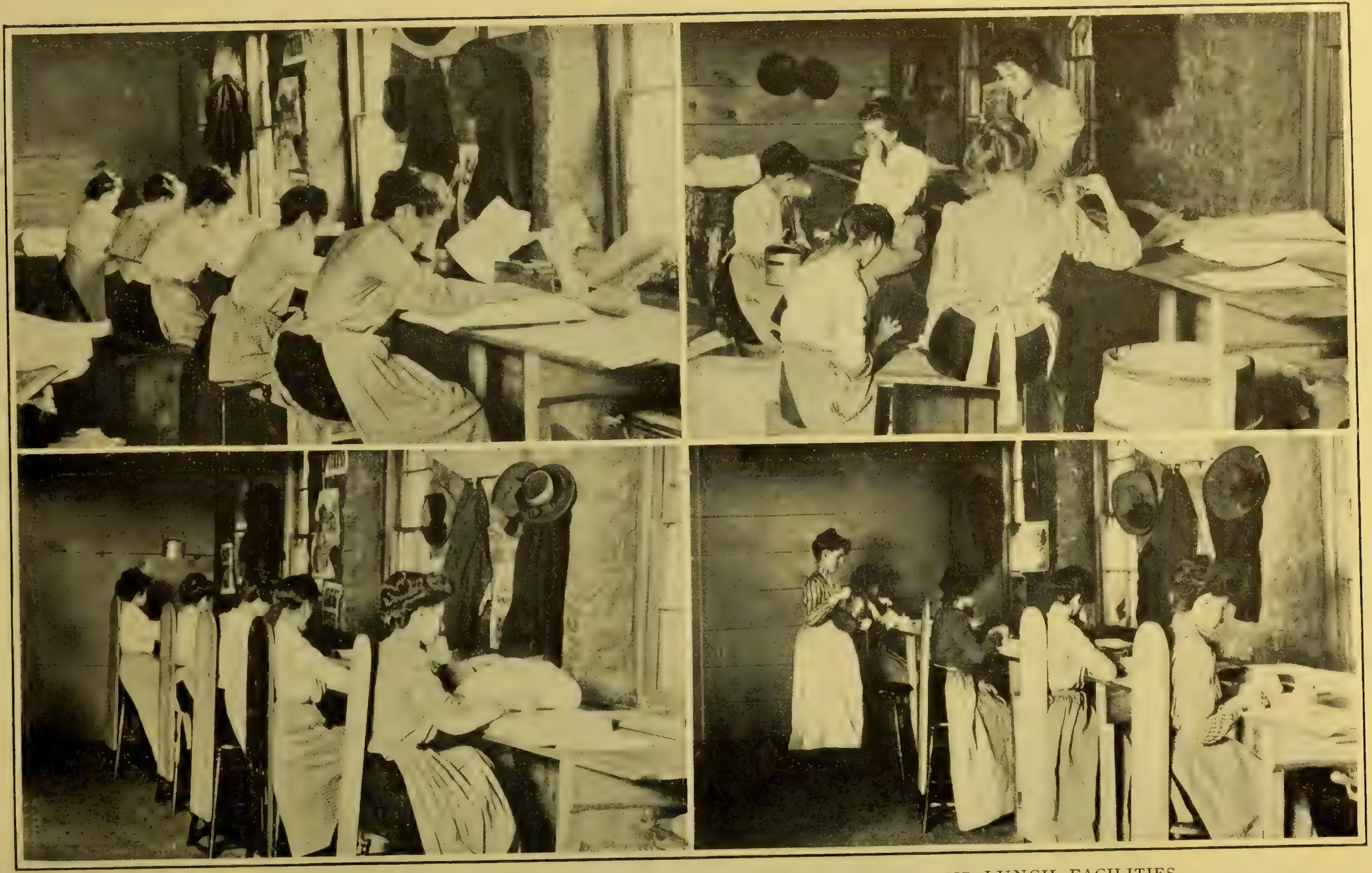
Some day a conveyor will handle the pieces better, and the man's energy will thus be conserved.

or boy should stand in front of a drill press, or almost any other machine, proper provision having been made for bringing up and removing material, than there is for a woman standing at a sewing machine. It is true that some occupations, particularly those involving attention to several machines at the same time, do not permit of much sitting or resting. But even in such cases there are certain to be, or at any rate there ought to be, short intervals when everything is going well so that the operator can for a few moments relieve the muscular tension. An instance of this kind is found in a certain factory whose output is a fiber product. One of the final operations is performed by girls, each one of whom attends to several machines. These girls lead a very strenuous life indeed during the ten hours that they put in daily, and not many are found able to continue at the work. Only girls of exceptionally good physique and endurance are able to do it. These girls have been provided with stools, and it has been found that they are able to make use of them to the extent of about sixty minutes a day, without in any way neglecting their work. The periods of rest are of course very short; but the aggregate is consid-



A CASE OF PROVISION FOR THE OPERATIVES' REST.

A strenuous job—balling twine. Formerly few girls could stand it long, and changes of operatives were frequent. The introduction of stools has permitted the girls to get about 60 minutes rest during the working day, a few moments at a time.



A SUGGESTION OF EVOLUTION IN SIMPLE CONVENIENCES FOR REST AND LUNCH FACILITIES.

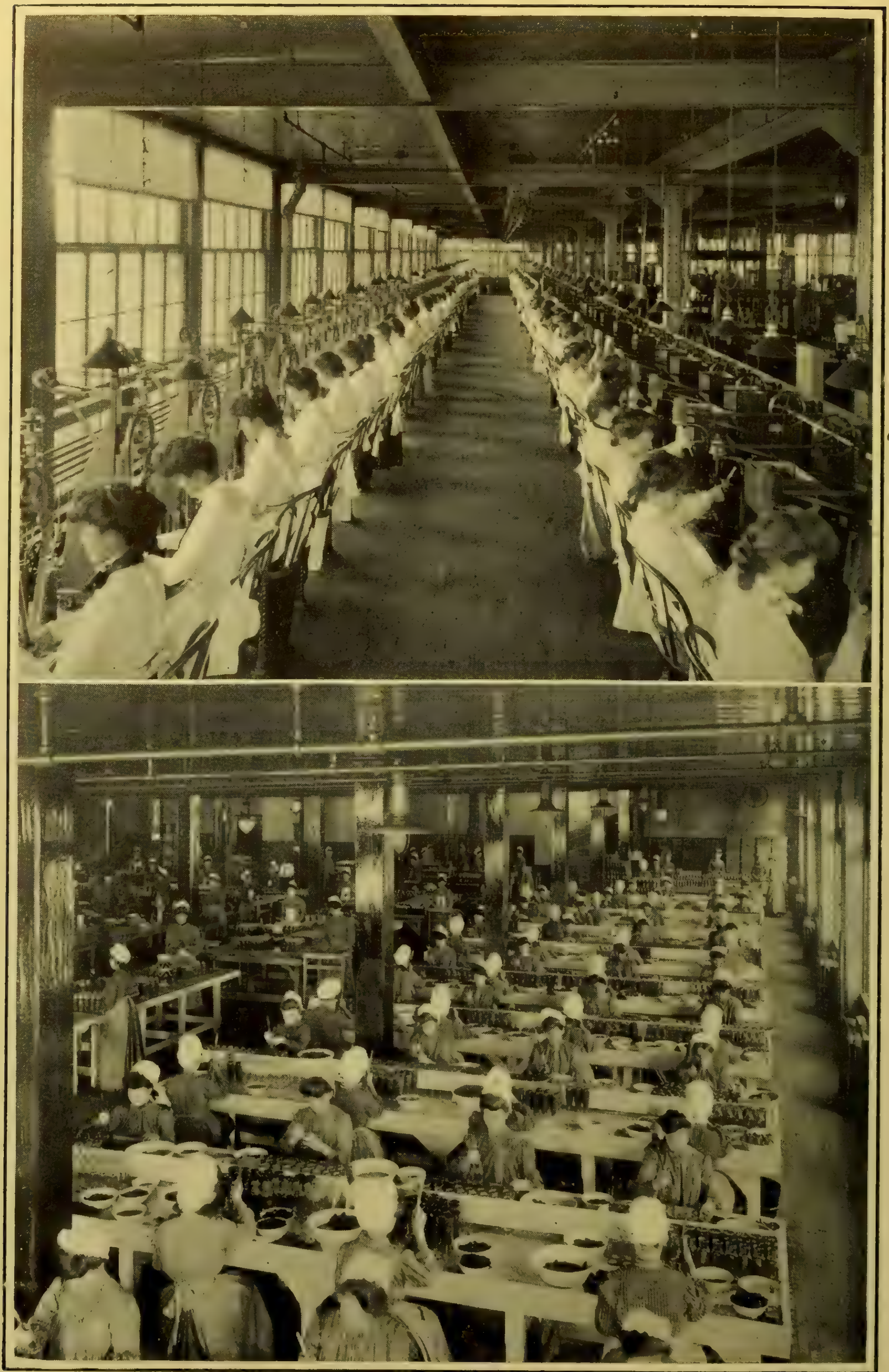
The upper picture on the left shows how wooden boxes may be pressed into service, when permitted by a management which recognizes that more and better work is produced when the worker's strength is conserved. The companion picture in the upper tier shows a similar adaptation to lunch-room "facilities"—crude enough, but by no means the worst offered factory employees. The lower left view illustrates a moderately satisfactory stool rigged up at small expense; the right lower corner, a simple lunch arrangement available where the work benches can be kept tolerably clean, though plainly inapplicable to the machine shop.

erable, and makes a great difference in the physical condition of the girls at the close of the day. It is to be regretted that the employer in this instance stopped short with a half-way measure instead of giving the girls chairs with back supports. The kind of seat has much to do with the rest it gives. A mere stool is good as far as it goes; but to give full benefit it should have back rests, and be of proper height so that the feet of the operator may rest upon the floor, or in case this is impracticable, foot rests should be fitted. But there are many jobs where it is necessary to be frequently, or even most of the time, on the feet, and in such case it is desirable that the stool be of such form as to admit of quick rising and sitting. In the absence of something bettter, an old packing box is susceptible of being made into a fairly comfortable seat.

It is a sad reflection on the intelligence of many a foreman, and even manager, that not only are no seats of any kind provided, but the use of any improvised by the workmen is discouraged, even forbidden. The attitude is of course that seats breed laziness and diminish output. A very little reflection and experience should convince even a slave driver that the more he relieves the unnecessary muscular strain of his workman the more energy is left to turn out work. Office managers generally have recognized the importance of this detail, and factory managers who have not already made similar provision might well take a lesson from them.

The physical condition of the workman of course depends upon many things besides the nature of his job and the extent to which it is fatiguing. The gases, dust, dampness, heat, or similar conditions under which he may be obliged to work, tend to impair his vitality and to breed disease. The amelioration and possible discontinuance of such conditions has already been considered. There are many conditions not under the direct control of the employer, such for instance as the nutrition, housing, and recreation of his employees. All these can be, and in a number of instances have been, successfully brought within the purview of the employer, to the mutual advantage of himself and his employees. Their discussion is reserved for another place, because they have to do mainly with activities outside the immediate working conditions now under consideration, and have only a general influence upon the health and *morale* of the working force of a plant. One aspect of the nutrition question however deserves consideration in connection with shop conditions; namely, that of facilities for getting and eating the noonday lunch.

Probably less progress has been made in this particular direction than in any other, even in those factories standing well to the front as



CARE FOR THE PHYSICAL WELL BEING OF THE OPERATIVES.

The stool used in the room shown in the upper view (lock and drill department, National Cash Register Co.) is very comfortable, though somewhat expensive and limited in application because of its fixed standard. Flat-top stools of simpler make are shown below (bottling department of the H. J. Heinz Co.) and suggest the possibility that the inspectors and sealers (at the left) might also be provided with seats.

exponents of altruistic principles applied to business. It is quite common to find arrangements in large industrial plants, and small ones too, for furnishing officers and foremen with the noonday lunch when such facilities are unsatisfactory or quite lacking in the vicinity. In a few notable instances dining or lunch rooms have also been provided for women employees of all classes. But there are a very few cases only where any attention has been paid to the problem of giving lunching conveniences to the ordinary workmen. Unless situated in the country, and frequently even then, the saloon with its free lunch and many doors facing every avenue of access to the factory, invites the hungry, thirsty, and usually dirty workman. For a small sum he gets his bucket of beer and a little spiced food, or gets the beer and eats a cold lunch, quite likely to be badly prepared and lacking nourishment. Under the prevailing conditions it is not surprising that so large a proportion of workingmen patronize the beer shop, to the disadvantage of their productive capacity the rest of the day. For it is a common testimony of foremen and others having to do with the supervision of workmen that the noonday patron of the saloon, and the "can rusher" where beer is permitted in the work shops, is likely to be drowsy and listless, and therefore working below his full capacity, the whole after part of the day. Usually the only alternative to patronizing the saloon and the curbstone is that of wiping a clean spot around the mouth with a bit of waste and eating with dirty or greasy hands a home-prepared lunch from a bench, or the nearest pile of material scattered about the floor. Aside from the quality of the food thus consumed, whether from the saloon, the curb, or the work bench, there remains to be considered something besides the inferior physical condition of the employees resulting from the use of foods so likely to be ill adapted and poorly prepared—namely, the attitude of workmen and workwomen toward an employer who thus insults their manhood and womanhood by expecting them to put themselves on so low a level. Many work people take such a condition as a matter of course, never having been accustomed to any other; but intelligent self-respecting workmen resent it, even though they may say nothing.

The justification for the so-called welfare institutions is twofold: the moral obligation of the employer to provide conditions of work that tend to the comfort, moral well-being, and self-respect of the employed; and the promotion of a cordial attitude on the part of the employee toward the employer. The saw often repeated among women that the way to a man's heart is through his stomach is generally applicable, in a measure. And though it may not in all cases

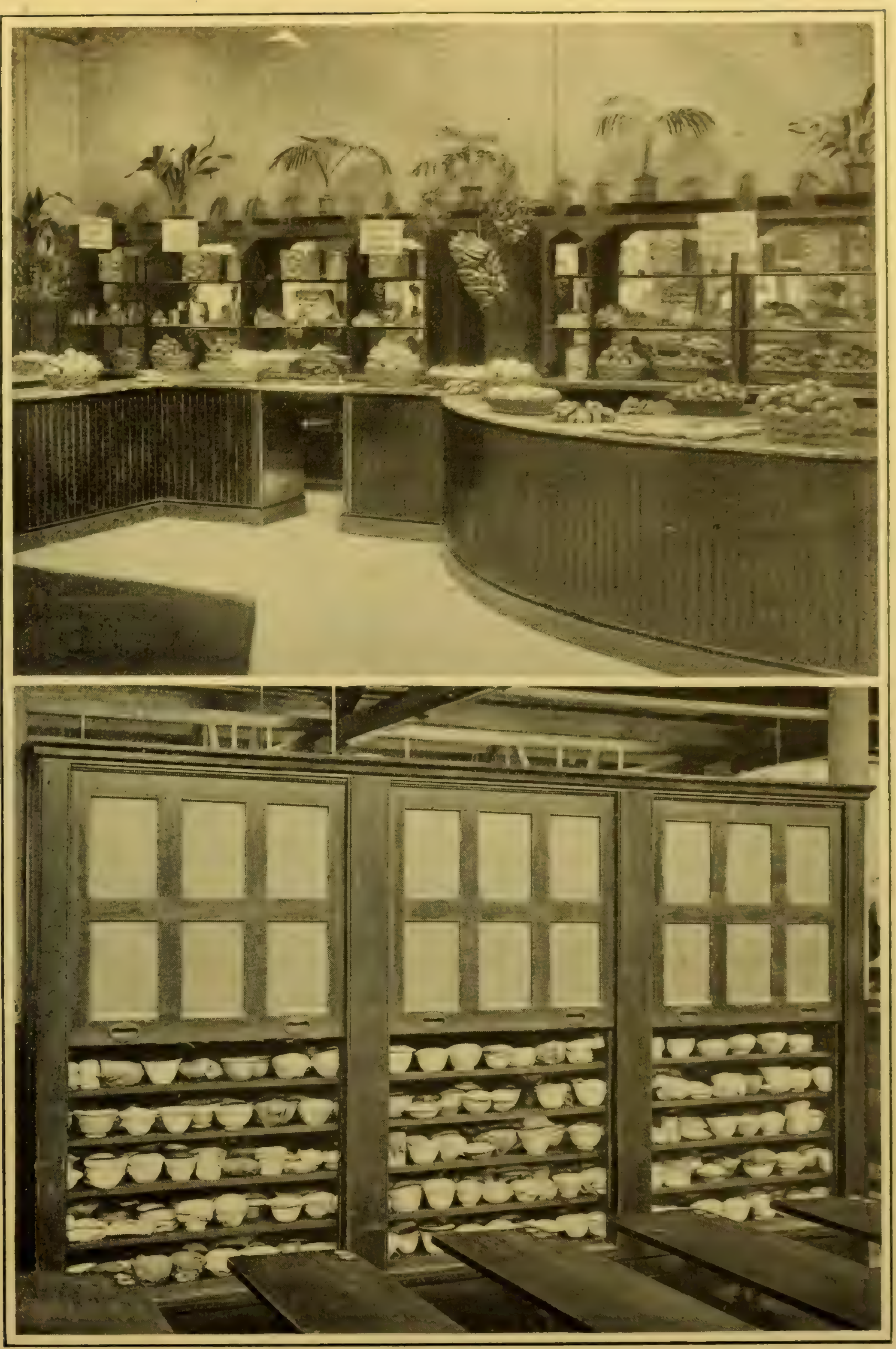
AN EASILY ARRANGED SHOP LUNCH ROOM.
Set in a space partitioned off from the working floor. Tables set on horses easily stored when "knocked down," and chairs also folding into small space. Acme White Lead & Color Works.

be expedient or desirable to furnish food, a genuine effort by the employer to give his people opportunity for decently eating a lunch, along with other facilities for observing the decencies, will go far toward promoting such a feeling.

It is not necessary, though often advantageous, to carry on a factory restaurant. Between such a course and that of do-nothing are several steps. The simplest thing that can be done, after providing facilities to wash hands and face, is to set aside a corner of the shop where tables and chairs are ready for use at lunch time. Since most shops are more or less dusty, it would be found troublesome to keep the tables fit for the purpose intended. For this reason and the further one of economy, it is better to have a small room partitioned off where the workmen from several adjacent shops, or in case of comparatively small plants, all the employees, may come together. Where the plant covers much ground and many floors, there ought to be several such places, enough to bring one of them into easy reach of every workman. The simpler the furniture, the more likely it is to be used. At one place tables with attached benches were made and set out of doors. These were used by many until they became filthy and fell into bad repair, no attention having been paid to them after they had been set out.

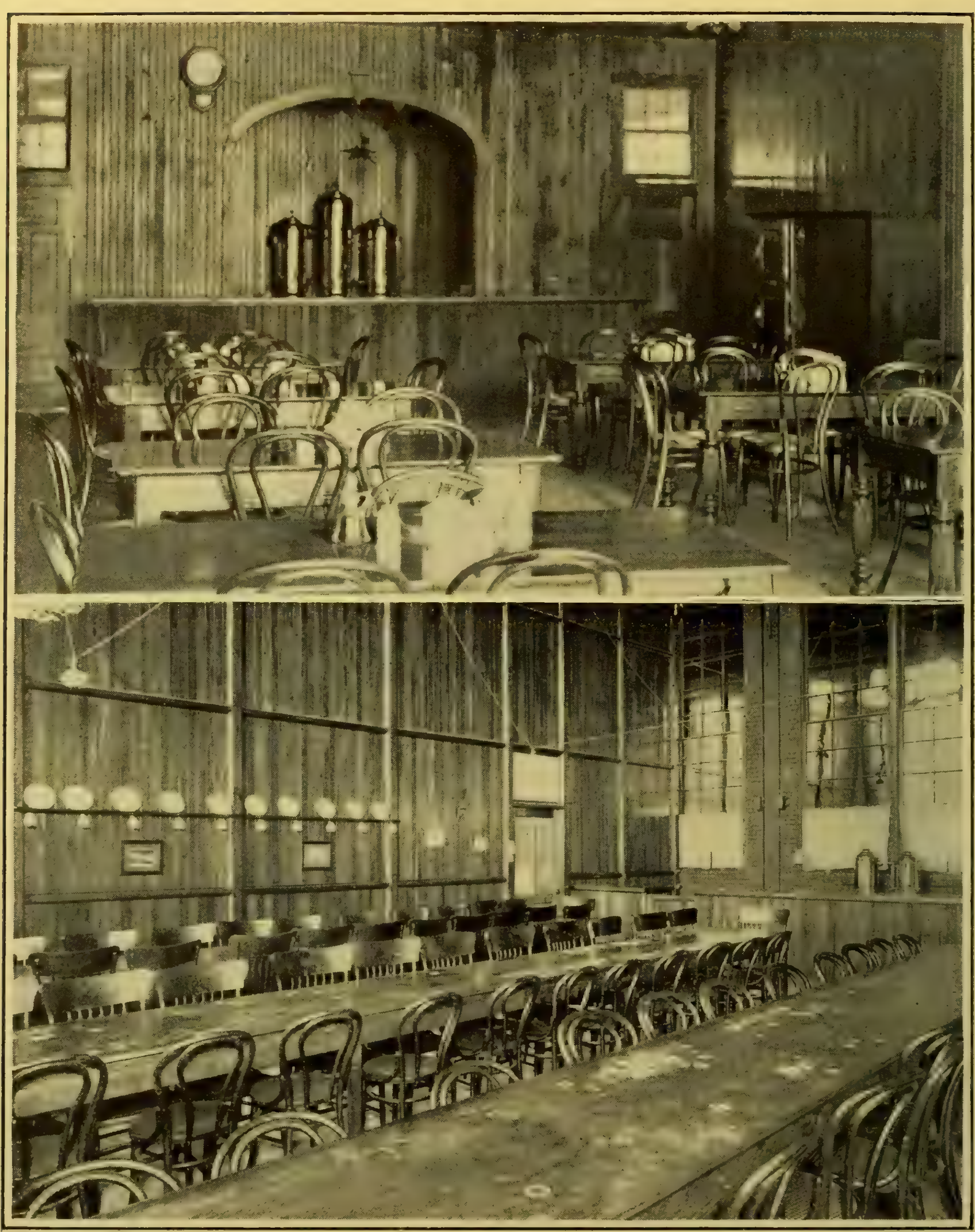
ANOTHER SIMPLE FACTORY LUNCH ROOM.
Sherwin-Williams Co., Cleveland, O.

A steam coil for heating coffee and warming



COMMISSARY INSTITUTIONS AT BOURNEVILLE.

The upper picture shows the fruit counters, over which fruit is sold to employees at a very low price during the lunch hour. The lower view illustrates the warmers, in which dinners brought from home by the work people are stored and warmed in time for lunch.



MIDDAY LUNCH INSTITUTIONS IN WELL-KNOWN SHOPS.

The upper picture is taken in the works of the Ludlow Mfg. Associates; "a coffee urn and a supply of cups is about all the equipment needed, apart from wash-sink, tables, and chairs." The lower view is in the McCormick malleable foundry—a corner cut off, with tables and facilities for securing coffee at 2 cents a cup, and for warming lunches in the near-by core ovens.

the food helps, and has been made a source of much satisfaction. In one case I know of the core-makers use the core ovens for warming up the lunches brought from home, and sometimes to roast potatoes or cook portions of other food. Steam tables and other devices are

A LARGE LUNCH ROOM CONVERTIBLE INTO AN AUDITORIUM.

A 15-cent lunch is served on the cafeteria plan. McCormick Works, National Harvester Co.

sometimes provided for a similar purpose, and in at least one instance a rather elaborate system of warming closets has been designed for holding and heating home-prepared lunches.

A favorite plan both with workmen and employers (where anything of the sort at all is undertaken) is an arrangement to sell good hot coffee, and sometimes other soft drinks, at a low price. Two cents a cup, it has been found, allows for a generous cup of such coffee with cream and sugar. In some places where this plan has been tried the coffee is sold for less, sometimes for a cent a cup. Not everybody buys, but many do. Neither do all the workmen make use of the tables at first, but many do; and in time, as experience has shown, practically all do so. Very few eat from a work bench or scrap pile by preference.

The hot coffee implies that there is to be an attendant for the lunch period and perhaps a short time before, if not for the entire day. In shops where there is a matron for the girls, there is no difficulty about this. A coffee urn and a supply of cups is about all the equipment required other than a wash sink. A little addition to the equipment by way of steam tables or ovens makes it possible to warm food brought from home: and a still further addition allows the preparation of such foods as soup, beans, and the like, which would be sold

AN OFFICERS' AND OFFICE EMPLOYEES' DINING ROOM.

L. C. Smith & Bro., new typewriter factory, Syracuse, N. Y.

in suitable portions, and consumed usually in addition to the food brought from home. The most satisfactory plan is to serve, from counters, after the "cafeteria" plan, a variety of dishes so that a full dinner may be selected. The prices must be small, but the service need not be at a loss. Some employers offer the food below cost and think themselves recompensed in other ways. Having the experience, they should know. In several instances coffee is furnished free of cost, and in others soup also. In still others a lunch is given to all required to work overtime.

The most important things to be considered in the conducting of such a lunch room or restaurant are three: first that the food must be of good quality and suitable quantity; second, the charge must be such as to bring it within the reach of every employee; and third, provision should be made for those who may choose to eat only what they bring from home. It is notoriously difficult to cater to all palates, under any circumstances; but a short experience will indicate what foods and what quantities are most satisfactory. The fixing of the price to be charged presents a peculiar difficulty aside from that involved in the cost of production and serving. Under average conditions the factory hand feels keenly, especially if there be a large family dependent upon him, every trifling expense, and therefore hesitates to buy a lunch when he is able to bring one of some kind from home. He will not spend even fifteen cents (a price at which a very satisfactory meal can be served) because he thinks he cannot afford to do so. The lunch room where is served only a full meal, or portions costing more than five cents or so, is little patronized by the men for whom such a place is primarily intended. This is an almost uniform experience in the management of factory restaurants and lunch rooms. The point is to set a price, if possible, at which the workman will feel that he can afford to buy one or more dishes and at the same time pay about what the same thing would cost if prepared at home. Factory men, as self-respecting workers, resent charity. Neither will they pay more for things, especially eatables, than the value to them. To meet this difficulty it may be necesssary under some conditions to sell the food at a price below the actual cost. This is most likely to be the case in small plants where experienced buying and the most expert mangement in the kitchen and dining room are not available. Where such buying and management are not out of the question, it is shown to be quite possible for a workingmen's lunch room to be self-sustaining and well patronized.

In a large factory it is necessary to consider also the question of

AN IMPROVISED LUNCH ROOM, OFFERING MUCH SUBSTANTIAL COMFORT WITH LITTLE OUTLAY.

Uses any vacant space on the factory floor. Tables and chairs are collapsible, and can be stored in small compass during working hours. Acme White Lead & Color Co., Detroit.

accommodating the men in the remote parts of the plant as well as those in the more accessible portions. The lunching room must be brought within their reach, physically as well as financially. There ought to be, under such circumstances, a number of lunch rooms pretty well distributed. If food be served in all of them, it would obviously be prepared at a central kitchen and distributed as required to the several places. By such an arrangement there would be no duplication of kitchen equipment; and production, being on a large scale, would be much more economical than if distributed among several kitchens.

The distribution of the prepared food presents no especial difficulty. It is readily accomplished by trucks designed for that purpose, and the use of steam tables and heaters at the dispensaries. It might be found advisable to serve food at part of the lunch rooms only; and perhaps no more than coffee, or coffee and soup, at others. The whole problem is very evidently one of local application, and must be worked out to meet the local conditions. It is equally evident that the problem is one to be worked out gradually. The simpler the be-

A LUNCH TRUCK IN USE IN A FACTORY.

Used in carrying coffee, warm dishes, and prepared food to the several shops and lunch rooms. Acme White Lead & Color Works, Detroit.

ginning, so long as it is an earnest of what is to follow, the more likelihood there is of ultimate success. The opening of a few rooms with tables and chairs has been mentioned as desirable in beginning. In one factory the men were first interested by the distribution of hot coffee to them at their work benches. The practice is still continued, under certain circumstances, though there are now several lunch rooms in operation in the plant. Another large factory almost by accident allowed a milk dealer to begin delivering bottled milk to certain of his customers while at work. Very quickly other workmen wished to buy, and in a short time the milkman was doing a flourishing business. It is a common sight at almost any hour of the day after the milk delivery has been made to see a workman refreshing himself with a drink from a white bottle and eating a slice of bread from the lunch box. The saloon-keepers of the neighborhood are unanimous in their condemnation of the practice, and it is asserted that because of it several have gone out of business.

Another innovation at the same place is the delivery of ten-cent prepared lunches by an outside concern. These lunches are put up in pasteboard boxes and are very satisfactory for the price, much better and probably more wholesome than most of the office men (who are the chief patrons of the lunch wagon) would be likely to bring from home.

Space is always at a premium in a manufacturing or trading plant, and very likely the first question asked, in considering the lunch room problem, is, where is the room to be found? Of course space is necessary; though probably not as much as might be thought. Room given to such use is not therefore nonproductive. A pleasant and neat room reserved for this purpose and perhaps also some sort of recreation yields rich interest in the education and good will of employees.

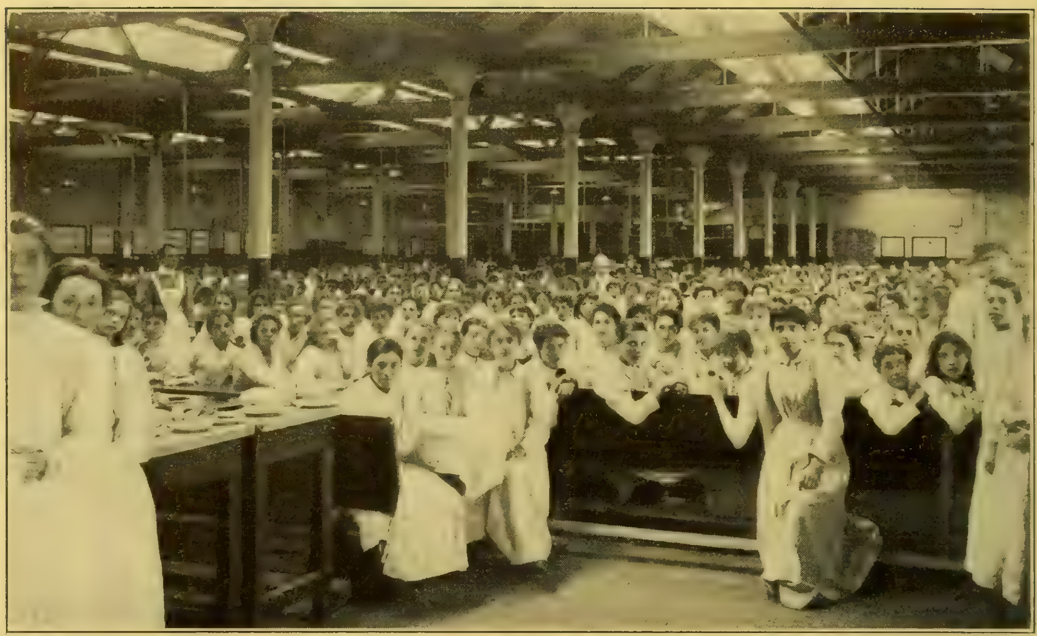
However that may be, it has been found that what might be called a convertible lunch room, used ordinarily for other purposes and at the proper time given over to tables and chairs, is quite feasible. An expedient that has worked well is that resorted to in one factory where table tops are hinged to the wall and swung out of the way when not in use as such. The chairs are suspended from hooks along the wall except at noon time. Another expedient available where wall space is wanting is that of swinging tables with attached benches from the shop ceiling by rope and tackle. Such an arrangement is very crude, but useful when nothing better can be done under the circumstances.

One other question that deserves serious consideration in connection with lunch rooms is the manner of serving the food. The counter plan so popular in the down-town restaurant has some advantages, including economy of space and convenience in serving. A few attendants can serve a great number of lunchers in a very short time. The disadvantages are well known to those that have patronized this sort of food dispensary.

The "cafeteria" plan, so called, in connection with suitable tables, is found to work admirably. Each diner takes from a counter such portions as he may wish, they being properly checked as he passes along. Economy of service is the chief consideration in this plan.

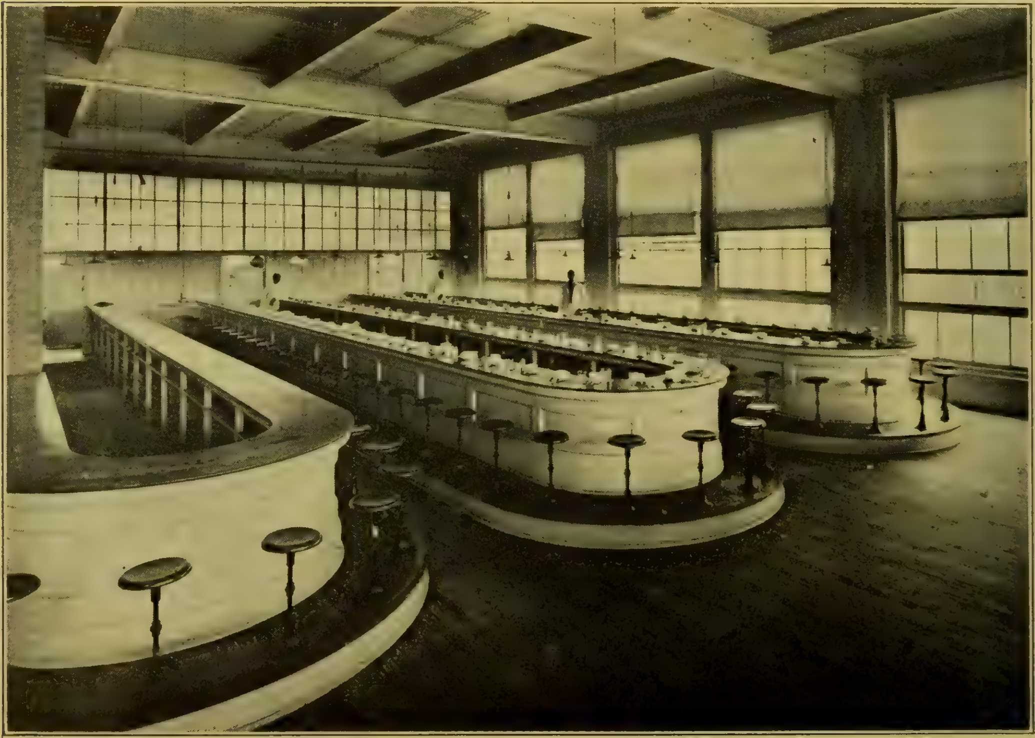
A MILK-DISTRIBUTING WAGON AT A LARGE ENGINEERING WORKS.

Maintained as a private enterprise by a reputable dealer, at no cost or inconvenience to the management, to the satisfaction of the men and the dissatisfaction of neighboring saloons. Deering and McCormick plants, International Harvester Co.



AN ECONOMICAL SPACE ARRANGEMENT OF A SHOP DINING ROOM FOR WORKING GIRLS.

Long, narrow tables and long benches make it possible to seat a great number of people in a given room. The illustration is from the Bourneville plant.



THE "COUNTER" PLAN OF LUNCH ROOM IN A LARGE ESTABLISHMENT.

It answers well the problem of economy in space and convenience in serving, but has disadvantages well known to all patronizing similar places. The view shows the men's dining room, Natural Food Conservatory, Niagara Falls, N. Y.

which is not often liked at first. The lunchers soon grow accustomed to the method, however, and patronize restaurants on this plan very freely. Unless this or the counter plan is adopted, the cost of service is an important item, the number of attendants necessarily being considerably greater.

When tables are used rather than counters, the arrangement of the former is of consequence. Of course it is more economical from space considerations to use long and narrow tables with chairs closely set. The disadvantage in such an arrangement is that it smacks a good deal of herding—something the men keenly resent. Furthermore, small tables permit the coming together of congenial groups and therefore a more free social spirit, which is one of the important considerations underlying the whole situation. Where it is possible, the use of many small tables, with room for four to eight persons, is greatly preferred. As to the table furnishings, not much can be said in a general way. Obviously this will depend much upon the class of work people catered to. Tablecloths and moderately fine dishes would be appreciated by a high class of women employees, and men as well; but the average shop man, who perhaps does not think it worth while to change coats or put one on and to clean up thoroughly before eating, would not go near such a table. Well cleaned table tops without covering, and very simple dishes, are usually to be preferred for shop lunch rooms.

THE SMALL TABLE HAS MANY ADVANTAGES, WHERE SPACE CAN BE AFFORDED.

The question of drinking water is closely related to that of lunch rooms, and in summer is of equally great importance. Astonishing as it may seem to a thoughtful observer, there are yet many factories where no provision whatever is made for quenching thirst—not even a water barrel. The lack of suitable provision in this matter is a serious inconvenience and not infrequently entails considerable suf-

INTERIOR OF GIRLS' DINING HALL, "PORT SUNLIGHT."
Factory of Lever Bros., Ltd.

fering. It may become a source of much evil and demoralization in a shop where the use of beer and other intoxicating beverages is not forbidden. The sight of a boy "rushing the can," carrying on a stick perhaps as many as a dozen buckets of beer at a time, is familiar about some shops. For moral and economical reasons whose validity is now pretty generally recognized, a good many employers permit no beer or liquor on the premises. Not all of them, however, provide anything better or even as good, and the employees are under the necessity of slaking their thirst with hydrant water, probably brought from some distance and too warm to be satisfying.

A system of supply pipes leading pure water to every shop and room in the factory, delivering it through a sanitary fountain, is, all things considered, the most economical method of handling the problem. If really pure water can be had in sufficient quantity to run freely and therefore remain comparatively cool, the result is satisfactory all round. Sanitary fountains, supplying the water in a small basin or from a goose-neck pipe so that no cup is used, are in any event desirable. This prevents possible contamination through the promiscuous use of the frequently dirty cup or dipper. A less sanitary and economical plan is that in vogue in a number of factories of placing barrels in convenient spots and keeping them filled with cool water.

A MODERN SANITARY DRINKING FOUNTAIN.

In such case ice can be used to advantage. A better arrangement is that of using ordinary water coolers, well distributed. A simple form of cooler is in use in some shops, consisting of a large wooden keg (or better, a stone jar) packed in a larger barrel. The space between is filled with sawdust. A very small quantity of ice serves to keep the water cool. In foundries and forge shops, or other places where the heat is uncomfortable, water alone does not give entire relief. A half pint of oatmeal or other form of crushed oats placed in the barrrel or cooler adds greatly to the thirst-quenching power of water. The flavor is not at first relished by some; but the taste for it is soon acquired, so that the beverage is used with much satisfaction. Where this drink is provided and generally used, it is very rare indeed that a prostration due to heat or excessive drinking occurs. Furthermore, it has the effect of reducing the desire for beer.

As the oatmeal sours in a day, it is necessary to clean and scald the tank or cooler, as well as the dipper or cups, thoroughly every day before a new supply is put in it. Faucets cannot well be used with the oatmeal water because the meal tends to clog them. Wooden spigots can be used if the oatmeal is put into muslin bags. This expedient also makes it easier to keep the coolers in a clean and sanitary condition. In some shops where the management has not taken up the matter, the workmen have made arrangements for a supply of water and ice, paying for the services themselves. There seems to be no good reason why the employer should not bear the expense; and the obviously increased efficiency and comfort of the men presents at least one good reason why he should do so.

PLASTER MINING AND PREPARATION IN THE VICINITY OF PARIS.

By Jacques Boyer.

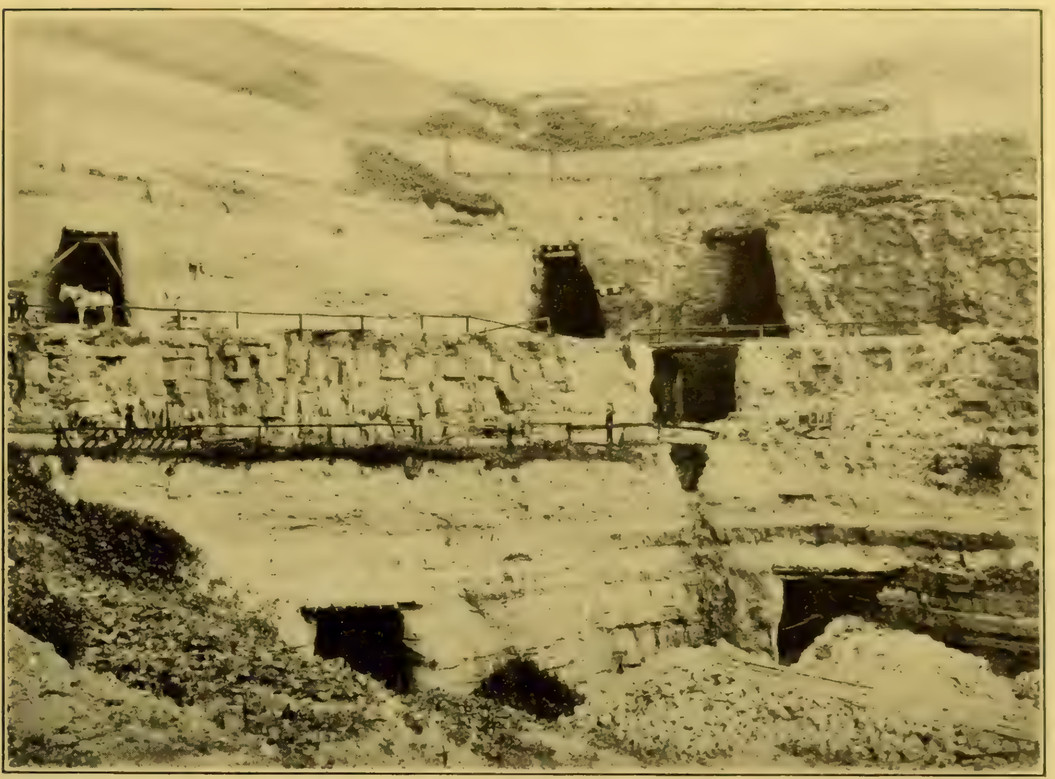
It has been recently pointed out in this Magazine that the increasing production and use of cement is one of the significant phenomena in engineering construction. This movement reflects an interest upon the older industry of plaster mining and preparation, and M. Boyer describes the methods in use in the most notable plaster-producing region of the world.—The Editors.

PLASTER is obtained by the calcination of gypsum, or sulphate of lime, which is found in vast beds in the neighborhood of Paris, and legend attributes its discovery to a shepherd of Montmartre. Cooking his food in an open-air fireplace, built in part of blocks of gypsum, he unwittingly manufactured plaster of Paris. A shower following wet the plaster, the dehydrated blocks of gypsum cementing together the adjoining stones, thus pointing the way to a discovery of the utmost usefulness to humanity.

Whatever may be the origin of the anecdote (and it is probably imaginative rather than authentic) it is certain that plaster was known to the ancients, as Aristotle and Pliny bear witness. It was employed first for making casts. It still serves the same purpose, throughout the world, the chief supplies being drawn from France; but gypsum is found also in America, England, Italy, Greece, and Germany. Its more important industrial use, perhaps, is found in building construction; the recent enormous increase in the use of concrete has been reflected in an enlarged demand for plaster, which is introduced into cement in large or smaller proportion to control the speed of setting.

In the basin of Paris, gypsum deposits are abundant under the hills on the right bank of the Marne, from Fère-en-Tardenois to the very heart of the capital; thence the bed skirts the margins of the Seine from Ivry to Suresnes. It then leaves the left bank of the river, to reappear on the right bank from Argenteuil to Meulan, reaching almost to Isle Adam in the valley of the Oise. The entire formation has roughly the form of an enormous lens, the thickness tapering gradually toward the borders.

The gypsum lies above a sandstone or grit, and is in three beds of which the lowest consists of alternating strata of gypsum and cal-

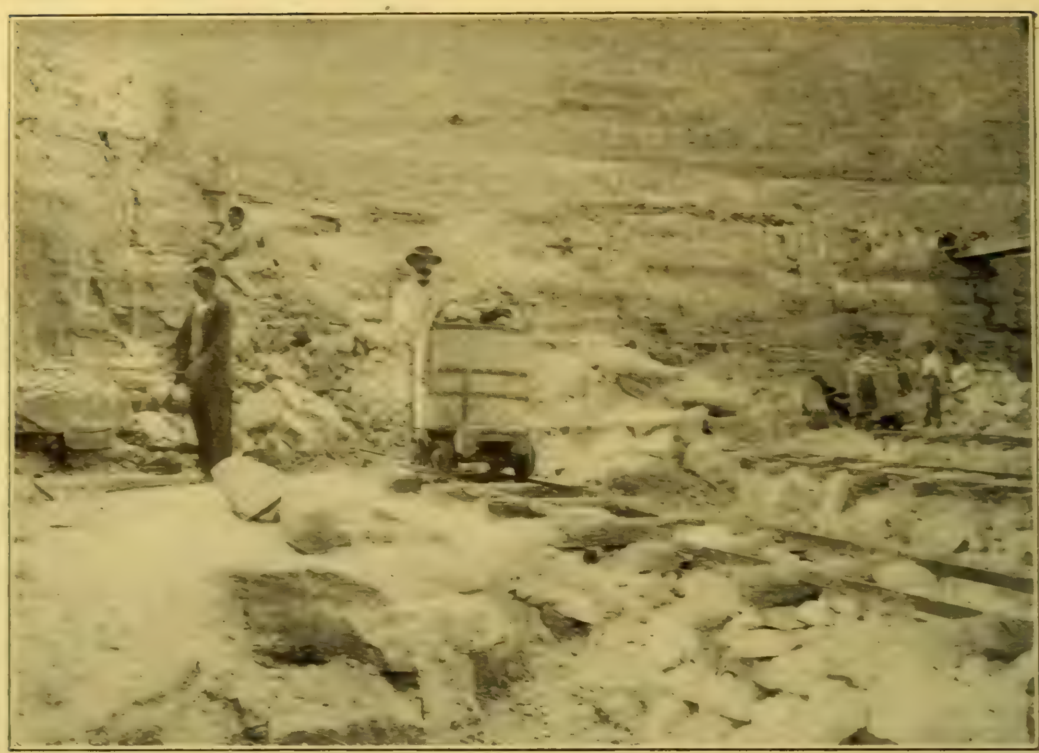


GENERAL VIEW OF GYPSUM WORKINGS NEAR PARIS. ENTRANCES TO THE MINED CHAMBERS.

careous and argillaceous marls, the former compact and the latter highly schistose. In the intermediate bed, the gypsum strata are more important, the marly layers are fewer, and fossil fishes occur; but the most interesting, from every point of view, is the uppermost bed—technically known as the "first" or "high" bed. It is heavier and richer than the others, attaining sometimes a thickness of twenty metres, and with very few intercalated marly strata; in some places it lies immediately under the tillable soil. It may be remarked, in passing, that it was in this bed that Cuvier found the remains of birds and mammals upon which he based his system of paleontology.

The Parisian plaster deposits are worked by open-air quarrying, by subterranean galleries, and by shafts, the most important workings being those of Romainville, Noisy-le-Sec, Montreuil, Bagneux, and Argenteuil.

Open-air quarrying is conducted by several methods, the first being that by "benches." The gypsum is first stripped of the overlying soil, and then the rock is removed, beginning at the top. The rock is thrown down by blasting, and as it is very soft, the shot holes are bored with an auger from two and one-half to five metres long. The designated depth being reached, enormous faces are blasted off, the gypsum being broken up after it has fallen.



OPEN QUARRYING OF GYPSUM-BEDS.

On the left, a workman is boring a hole with a long auger; the others are throwing down and breaking up the detached blocks, which are finally wheeled away in the little trams.

The second open-cut method is by undercutting, or "*chute.*" The highest stratum is stripped, and the marls separating it from the next lower layer are cut away, the overlying mass being supported meanwhile with the additonal aid of props called *chandelles.* Having undermined as large an area as it is proposed to drop at one time, shot holes are bored in the pillars which have been left to support the roof, and the charges are placed, care being taken to have the fuses of the front row shorter than those further back. The stulls are then removed, and the shots are fired. The short-fuse holes in the outer row, by their earlier explosion, facilitate the fall of the roof, as the second and third rows successively follow. In the plaster workings near Paris, 6,000 to 7,000 cubic metres are sometimes broken down thus at a single firing.

At Romainville (Seine) subterranean workings are carried on as shown in some of the accompanying photographs, taken at the quarries of M. Gauvain. The general view shows the tunnels or drifts, opening on the slope of the beds like a range of gigantic doorways. The walls of these adits are shaped obliquely upward to the form of a pointed arch, forming a natural roof which is further strengthened by heavy timbering.

The work of the miner is executed chiefly with the pick (called "s" by the laborers) and is the more trying because it often has to be carried on while the miner lies flat. In any case, the rock is broken down step by step, as in open-air quarrying, the miner working in as far as the length of his pick-handle permits, and then enlarging the under cut by small shots. He removes the debris, and continues his laborious excavation, working gradually upward until he reaches the roof. As the face is advanced, stulls are set and well capped with crossed timbers to support the roof pending the permanent timbering, for which oak is employed.

When this stage of the mining is completed, the *chandelles* or temporary timbers are removed, and the *coupeur* gang proceed to finish the work. They rob the pillars left as support for the roof, dressing down their faces with the pick and cutting them away from the working face of the chamber. When the excavation thus made is sufficiently enlarged, they bore auger holes for blasting to hasten the operations.

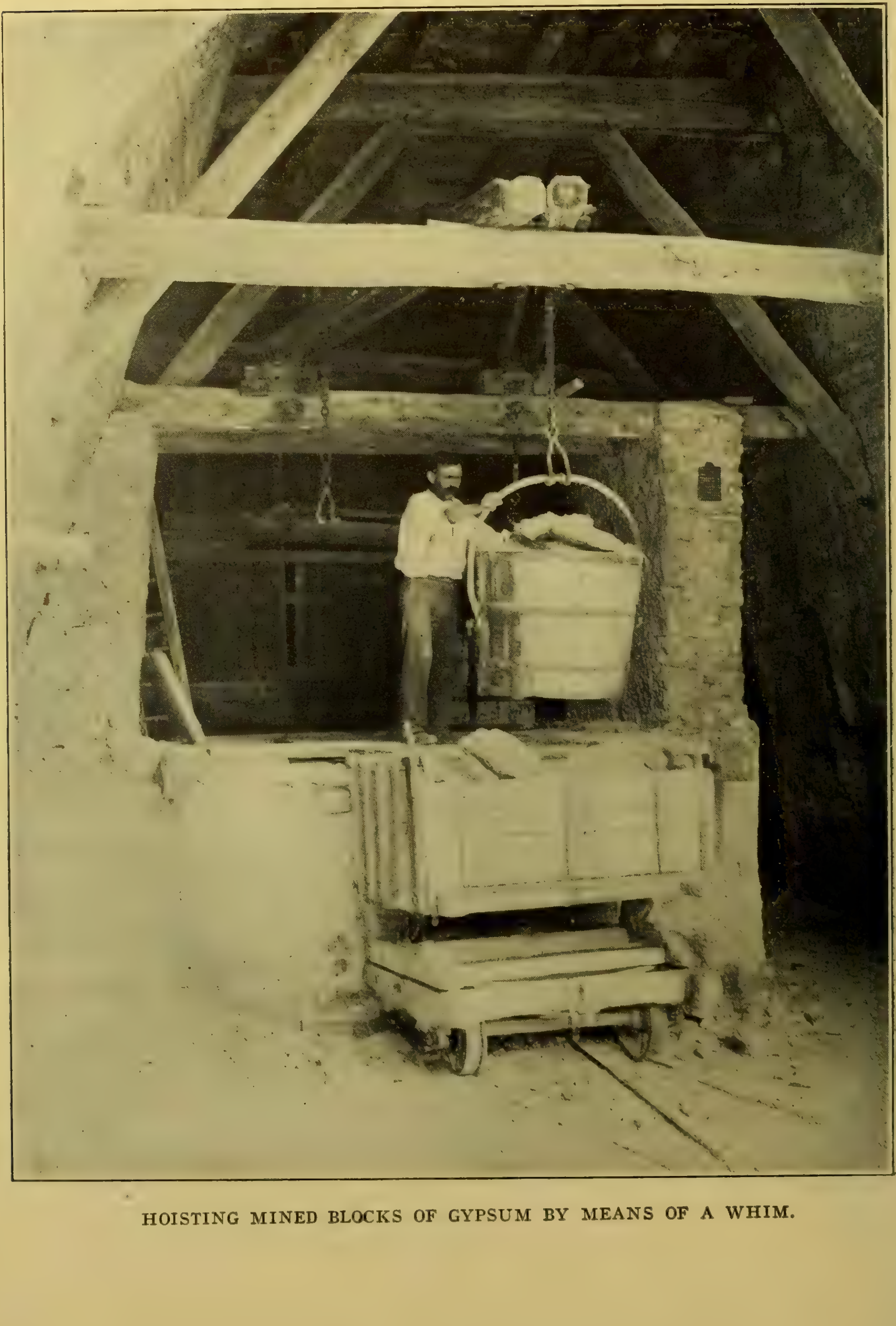
Shaft mining is applied chiefly to the working of the third or lower bed, and the hoisting of the mined blocks is still effected in the Parisian gypsum quarries by the most primitive means. At Romainville, for instance, the work is often done by a horse whim operating

WORKING BY SUBTERRANEAN CHAMBERS.
Miners drifting with picks.

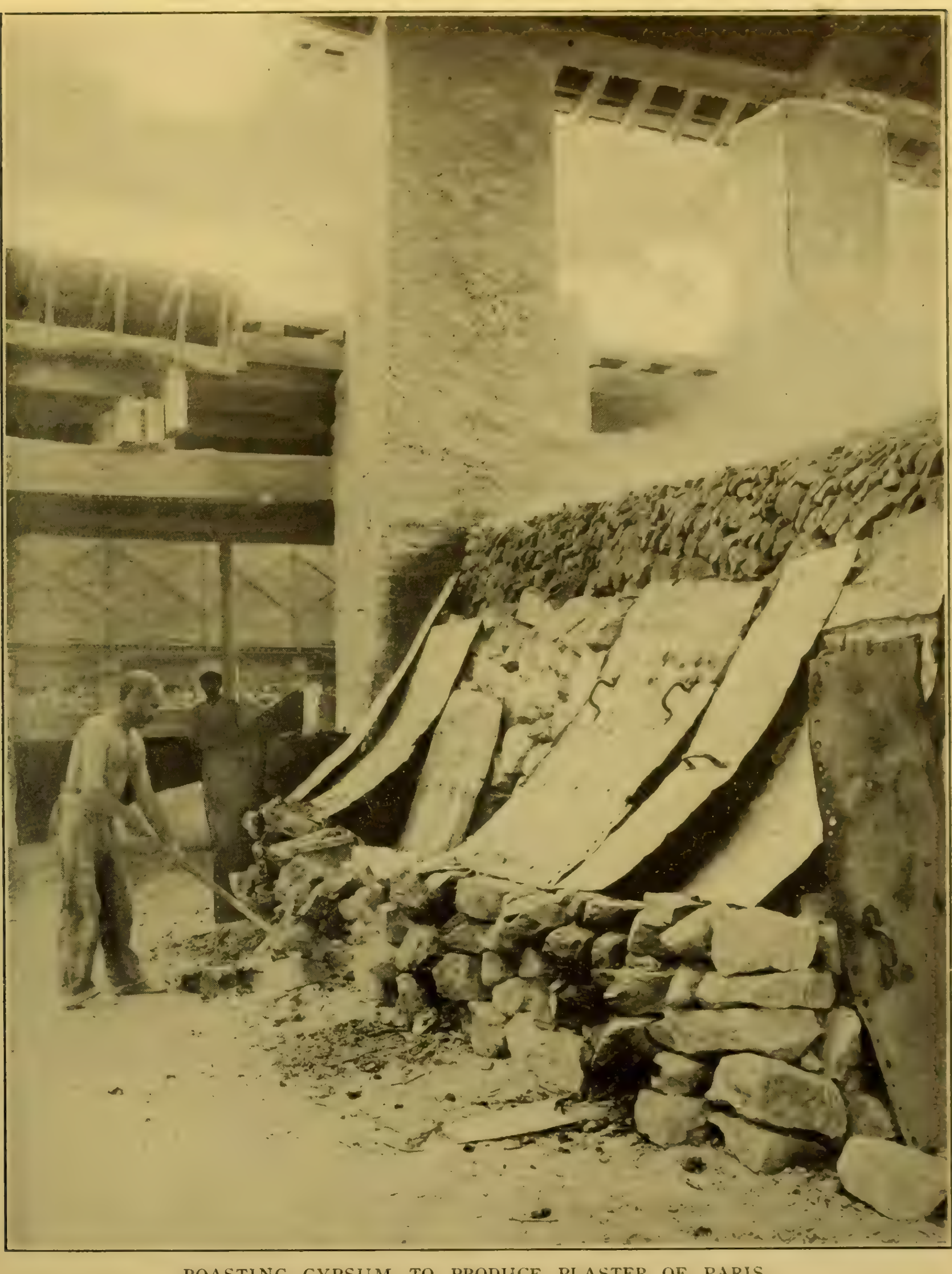
a winch which hoists a loaded skip; this is dumped by hand into small trams.

After the gypsum has been mined and broken into pieces, the next step is to calcine it to remove the water of crystallization, and thus transform it into plaster, which is further ground.

Roasting is accomplished at a temperature between 80 and 200

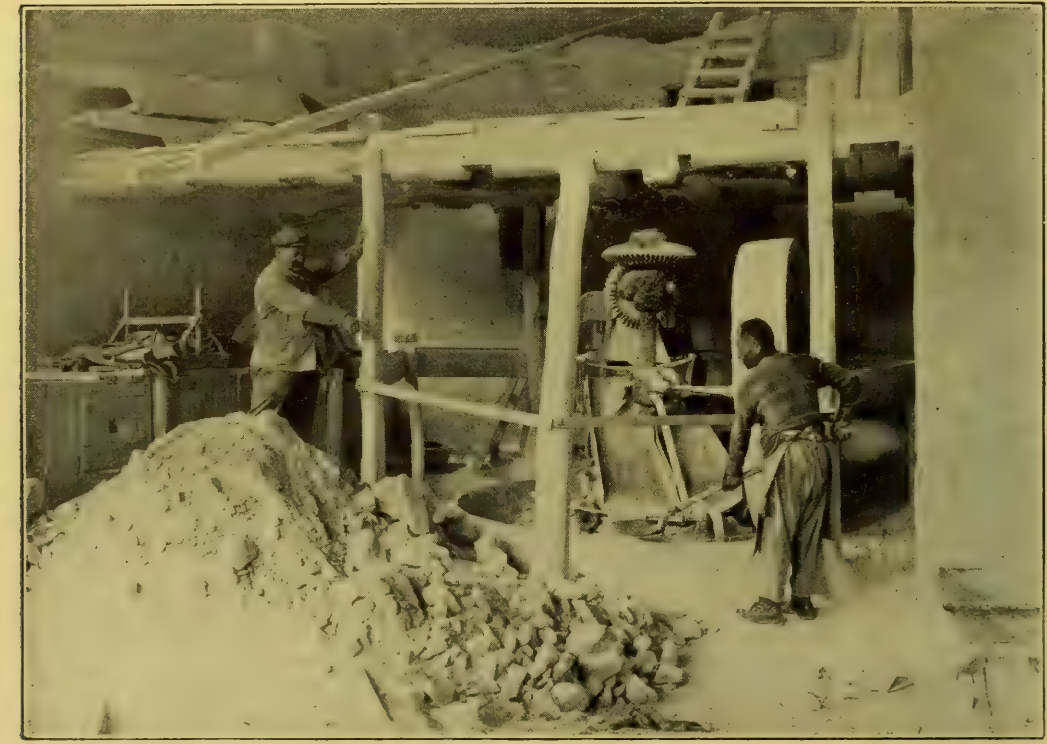


HOISTING MINED BLOCKS OF GYPSUM BY MEANS OF A WHIM.



ROASTING GYPSUM TO PRODUCE PLASTER OF PARIS.
Toward the close of the operation, sheet-iron plates are laid over the arches to check loss of heat by radiation.

degrees C. Above or below that, according to M. Henri Leclaire, the product obtained is inert, incapable of absorbing water or of setting when used in mason work. The roasting is effectively carried out under sheds protecting the piles from the rain, as shown in the illustrations. The "furnace" is built of the gypsum blocks themselves. At the base are placed the larger pieces, arranged in the form of arches. Upon these is laid the fuel (wood, coal, or coke) and the structure is built up with smaller and smaller pieces, passages being left for the discharge of the smoke and vapor. Toward the close of the operation, which lasts about ten hours and treats some 500 cubic metres of rock at a time, sheet iron is placed over the arches to prevent loss of heat by radiation. Each roasting heap requires two attendants for the building and the management and drawing of the fires, and two operatives for hauling in and hauling away the material.



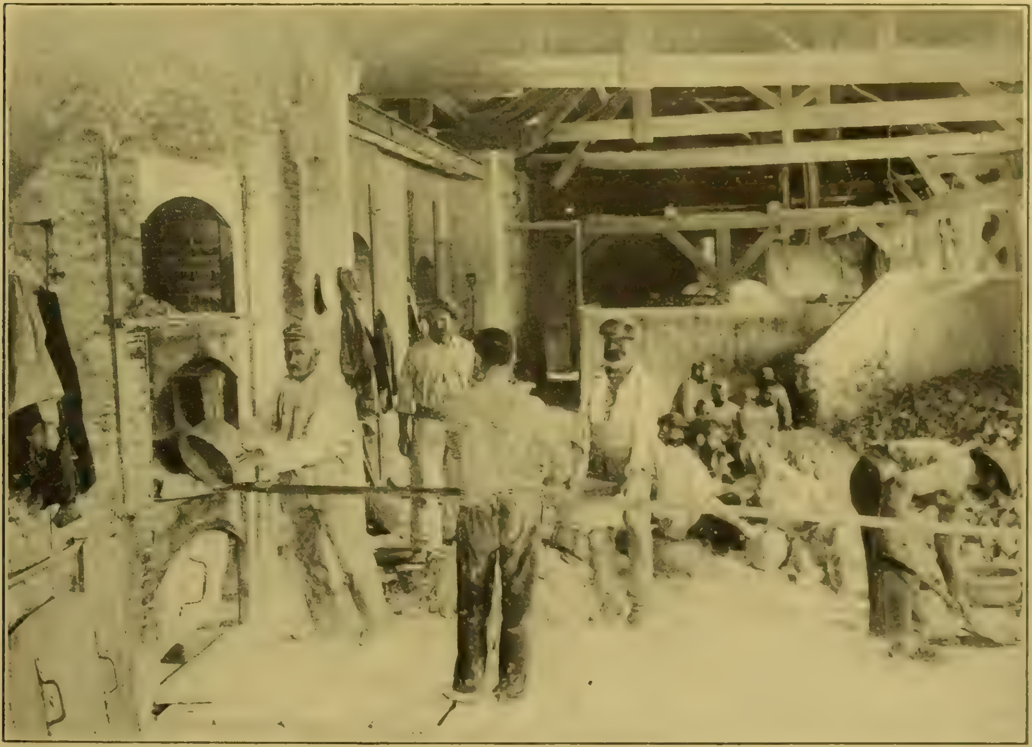
GRINDING THE ROASTED PLASTER.
A bucket conveyor carries the crushed material to a central screen.

After roasting the pile is allowed to cool for five or six days, and then the rock is pulverized. A half-century ago, this crushing was accomplished by spreading the material on the ground and beating it with a tool called a *bedu*—whence the French expression "to beat like plaster." Nowadays this primitive process is replaced by the use of steel mills revolving in a circular trough with a perforated bottom. Some of these mills are equipped with bucket conveyors, carrying the ground material to a central screen of varying fineness. That part which is sufficiently ground drops through, and the remainder is returned to the bed of the mill. The plaster manufacturer can thus secure the degree of fineness of grinding demanded by his trade.

Plaster intended for statuary or architectural decorative purposes is made in similar fashion to that destined for constructive work, but greater care is used in its preparation. The gypsum is first selected carefully, and then air-dried for some months. It is then broken into pieces by workmen with hammers. The roasting is effected by thrusting the fragments on a long spade into a furnace similar to a baker's oven. After it is roasted, the plaster is pulverized and screened through hair or silk bolting-cloth, according to the fineness desired.

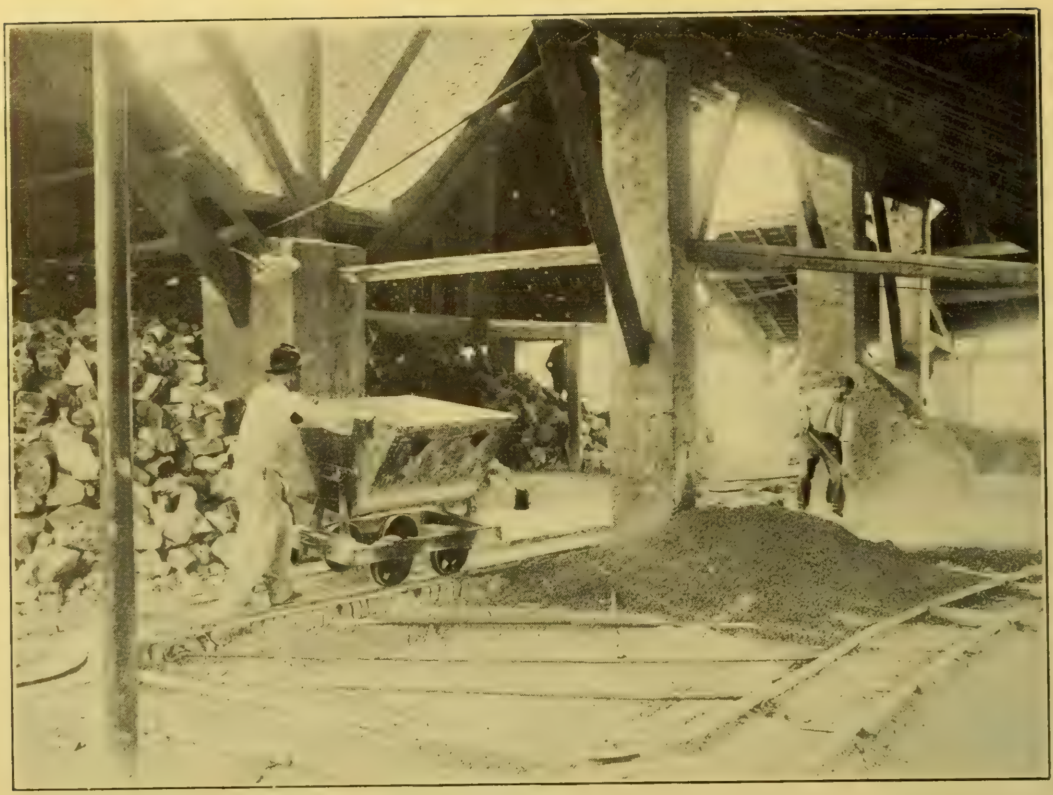
For stucco work, use is made either of ground plaster mixed with strong glue or of aluminated plaster, obtained by a second roasting with an admixture of alum. Skilful workmen can give to plaster thus prepared a beautiful polish, and by admixture of various metallic oxides can imitate all the shades of marble.

Ordinarily the pulverized plaster is carried up to and deposited on a second-story level, from which chutes lead down to the ground floor. There the workmen attach sacks to the mouths of these tubes, and by means of sliding gates in the chutes draw down enough to fill each sack in turn.



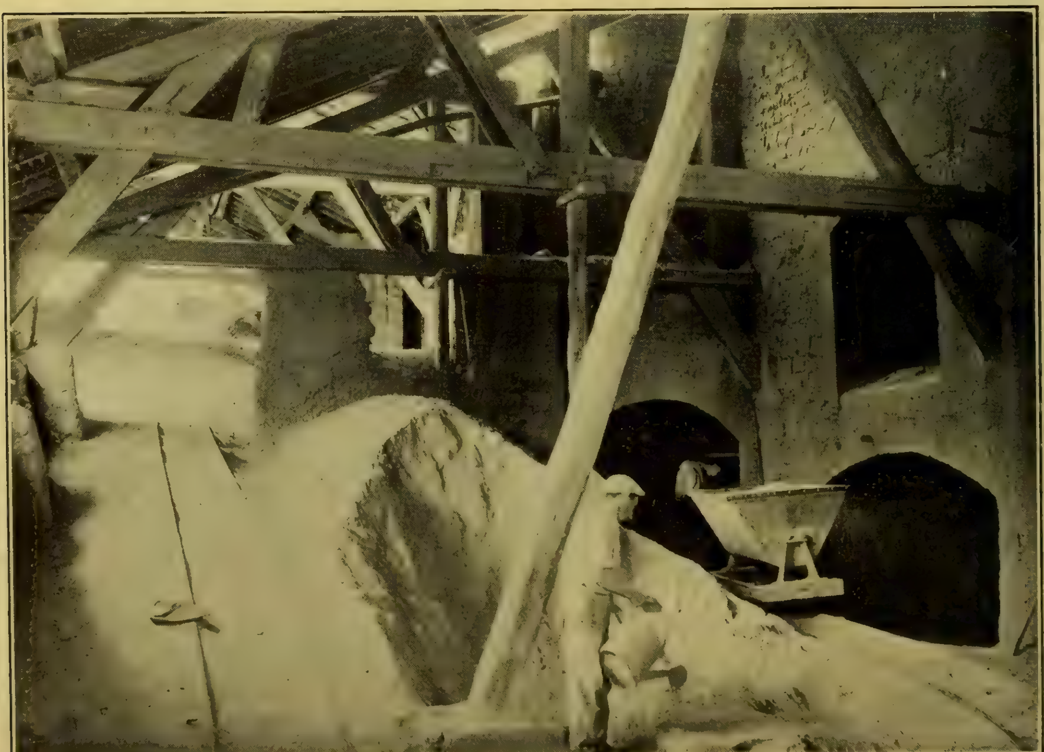
MAKING MOULDING PLASTER.
Breaking up and furnace-roasting the gypsum.

Apart from its use for building purposes, plaster is employed in ice making, in the manufacture of porcelain, and in the production of casts. It finds application in agriculture also, either crude as it comes from the quarry, partly dehydrated in special furnaces, or completely roasted as already described. Its fertilizing properties, first



TOP OF LIME KILNS.

The nearer one is being charged; the further one (on the right) is burning.



SLACKING QUICK LIME.

noted by Meyer de Compterzel (1767), were brought into special prominence by Franklin.

At the present time the plaster workings in the environs of Paris, developed by some eighty companies, furnish annually 1,600,000 cubic metres and employ 5,500 workmen. In some of them are treated also calcareous marls which are found in connection with the gypsum strata. The decomposition of the carbonate of lime is effected in furnaces or kilns, built of masonry; the two illustrations shown, taken at the works of M. Gauvain, at Romainville, show the general arrangement. The kilns are lined with firebrick, as the limestone must be heated to redness for many hours. When the burning is complete, the fire must be extinguished to draw the charge, if the process is intermittent. Nowadays, however, the intermittent working is generally giving place to continuous kilns, having a special opening permitting the withdrawal of the charge. As the furnace is emptied from below, it is correspondingly filled again at the top.

SACKING THE FINISHED PLASTER.

As it comes from the kiln, the quick-lime has a high affinity for water. It is sprinkled to convert it to slacked lime, which breaks up and falls into powder. In this state it is delivered to manufacturers, chemical works, and agriculturists, by whom in France it is consumed in large quantities.

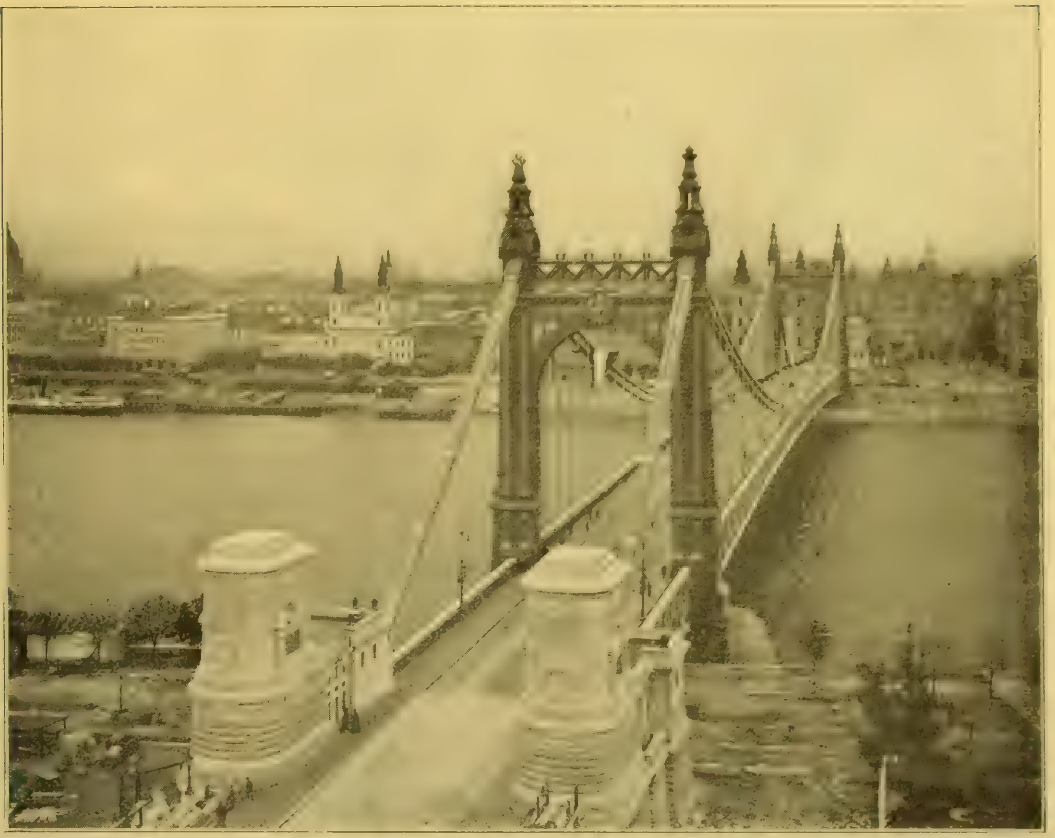
THE ELIZABETH EYE-BAR SUSPENSION BRIDGE AT BUDAPEST.

By L. Ramakers.

The author indicates clearly in his opening paragraph the interest which attaches to the Elizabeth bridge as a completed example of the style proposed for much larger structures in and about New York City. It is interesting further because of the very large part in its construction played by distinctively mechanical processes, and of the great consideration given to aesthetic elements in the design.—THE EDITORS.

THE new "Elizabeth" suspension bridge at Budapest, as will be seen at once from the accompanying illustrations, has a double interest; first, in that it witnesses the return to favor of the suspension type, and second, in that it is almost identical in conception with ex-Commissioner Lindenthal's project for the new East River bridge to be built by the city of New York. The distinctive feature of that was to have been the eye-bar chains, but although warmly approved by the Municipal Art Commisssion, the plans were rejected for various reasons more or less well grounded. At all events, the construction of the Budapest bridge has demonstrated that the eye-bar chain is not only amply satisfactory in point of strength and rigidity for the weight of metal used, but that further it puts a true artistic stamp upon the whole structure.

This new suspension bridge, with a simplicity of line which harmonizes admirably with the wide horizon of the river and the town, spans the Danube with a center opening of 290 metres and shore spans of 44.3 metres each. It completes a series of artistic structures designed, as the need has gradually increased, to accommodate the traffic between the two cities composing the Hungarian capital. Six permanent bridges (including the Elizabeth) now stand within the limits of Budapest; two of them carry railways, above and below the town. Three others are projected, and one of these is already planned. At present, within a distance of 2,500 metres, one may see four important bridges—the Marguerite, built in 1876 and enlarged in 1899; the first suspension bridge, built by the English engineer Clark in 1840-1849; the Francis-Joseph bridge, finished in 1896; and lastly, between these two latter, the Elizabeth bridge (Erzsébet-hid), of which this short description is given from notes supplied by M.

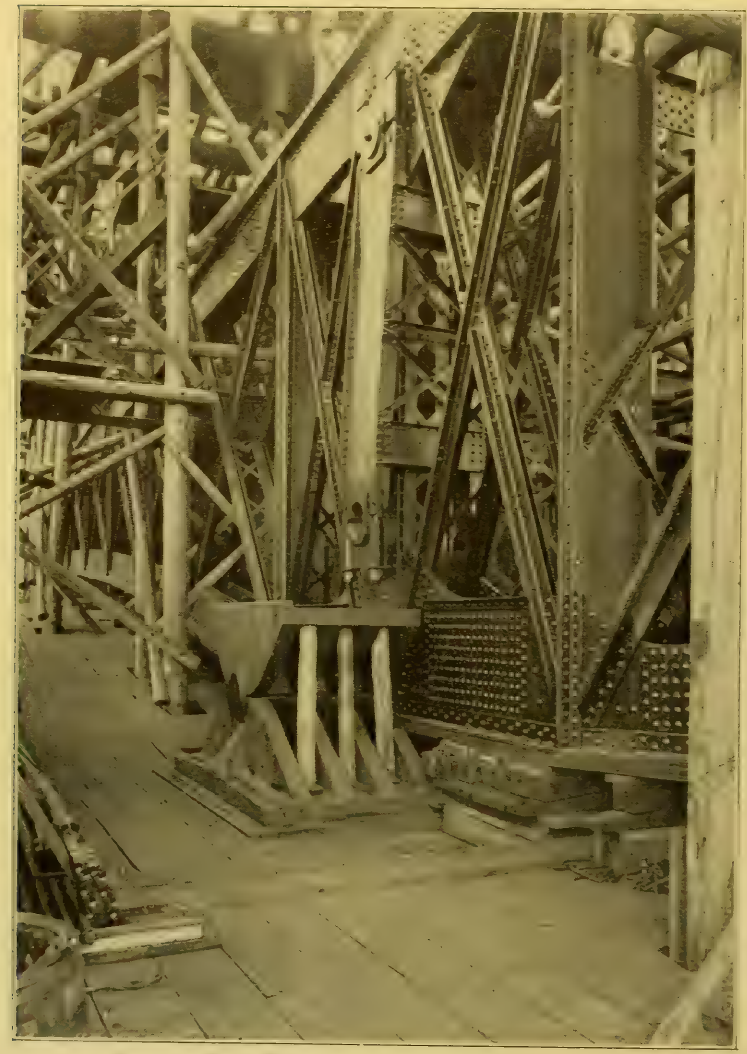


THE ELIZABETH EYE-BAR SUSPENSION BRIDGE, BUDAPEST

Czekelius, the engineer under whose direction it was planned by the bridge department of the Hungarian Ministry of Commerce.

Of all modern Hungarian bridges the Elizabeth is most important, whether for general dimensions or for the length of the principal span. The designers could readily have increased this length, if they had not elected rather to be controlled by æsthetic considerations. The panorama of the Danube at this point is magnificent. The two immediately neighboring bridges—the old suspension structure (Lancz-hid) and the Francis-Joseph of cantilever type—present almost the same general aspect. It was desired this time to vary the proportions slightly, in order to avoid the monotony which would be created by a series of structures all exhibiting the same controlling lines. The piers are brought very close to the banks of the river, and the shore spans placed just above the quais, so that the entire width of the stream appears to be bridged by the single central span.

The architectural elements of the design are the work of M. Nagy, who had charge of the same features in the Francis-Joseph bridge. All the materials entering into the structure are of Hungarian manufacture, so that the complete work is regarded by the nation as synthe-



THE HINGED SYSTEM OF THE STIFFENING TRUSS OF THE ROADWAY.

sizing the states of development reached by the engineering profession and the structural industry in their country within the past few years.

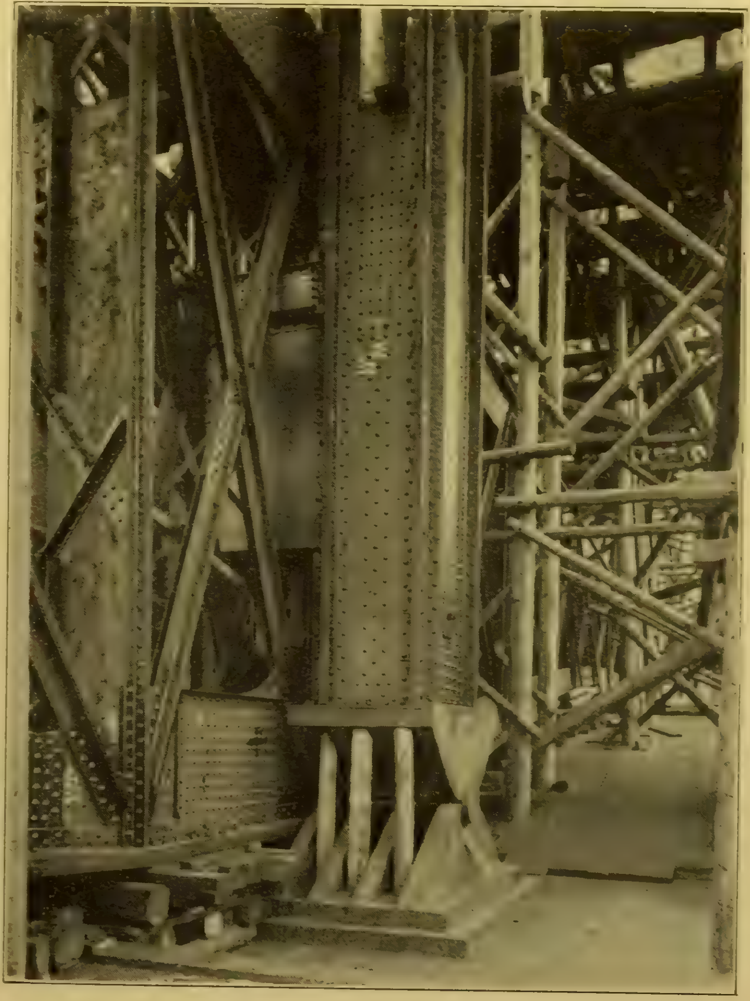
The Elizabeth bridge carries a roadway, with footwalks on both sides. The rigid floor is composed of two continuous principal trusses, of which the upper chords form a continuous arc throughout the entire length of the structure, while the lower chords form arcs of different curvatures in the central and side spans. It is suspended from chains carried over steel towers, hinged at their bases upon rollers carrying the load to masonry foundations. The stiffening truss rests upon hinged struts at the towers and at its extremities on the masonry abutments.

There are two eye-bar chains on each side of the bridge, superposed and about 1.50 metres apart. The suspender rods are fixed alternately to the upper and the lower chain. The ends of both chains are anchored in massive masonry; their highest points are 50 and 51.5 metres respectively above low water, and the depth of the catenary is one-tenth of the span. The two side spans are so short that it was not thought advantageous to suspend them from the chains.

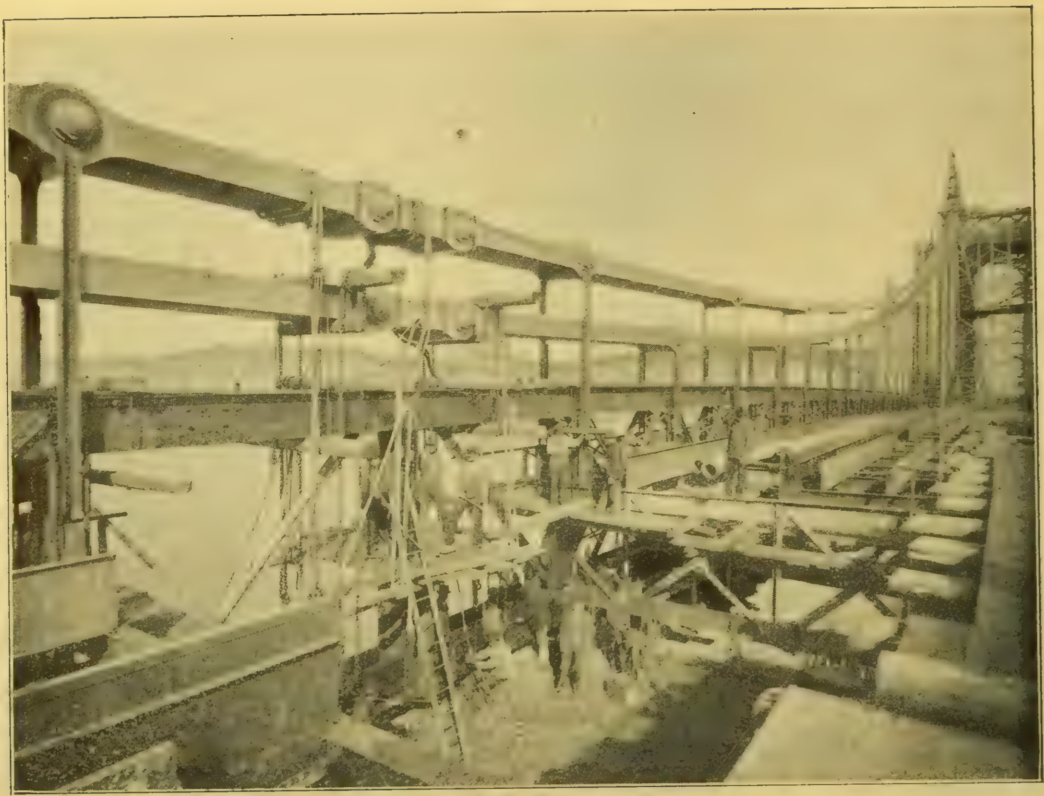
The two piers forming each tower are connected together by cross-bracing and treated architecturally as decorative portals. The steel rollers, two under each pier, carry a load of about 7,000 tons (metric); they are 30 centimetres in diameter, each supported in two cast-steel pillow blocks weighing 15,500 kilogrammes each.

The floor is 20 metres wide betwen centers of the chains and of the principal trusses—18 metres inside the guard rails. The chords of these trusses are U-shaped, the upper one parallel to the roadway and 1.25 metres above it. To the passing traveller on the roadway or footwalk, therefore, the view is unobstructed save by the suspender rods, which are spaced generally 6 metres apart. The footways are built of corrugated steel covered with asphalt, and are 3.60 metres wide; they are supported on light girders. These, as well as the stringers of the carriageway, are carried on lattice girders resting on the principal trusses and diagonally braced. The whole bridge is strongly braced and stiffened throughout, with the aim of offering ample resistance to lateral strain.

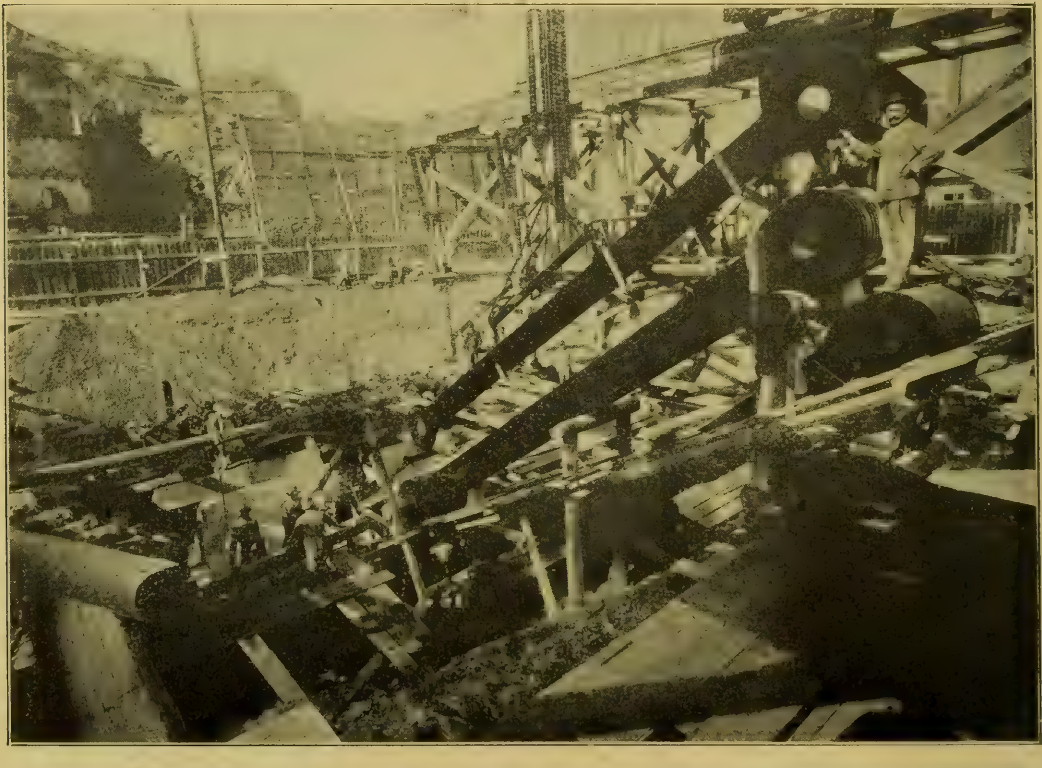
The pull of the chains upon the anchorage masonry—calculated at 6,600 tons—is distributed upon anchorage sole plates of ribbed cast steel, weighing 6,750 kilogrammes each, which themselves bear against a bedding of hard stone. The two chains in each anchorage are tied together and held parallel at the spring by



THE HINGED BASE OF ONE OF THE TOWER PIERS.



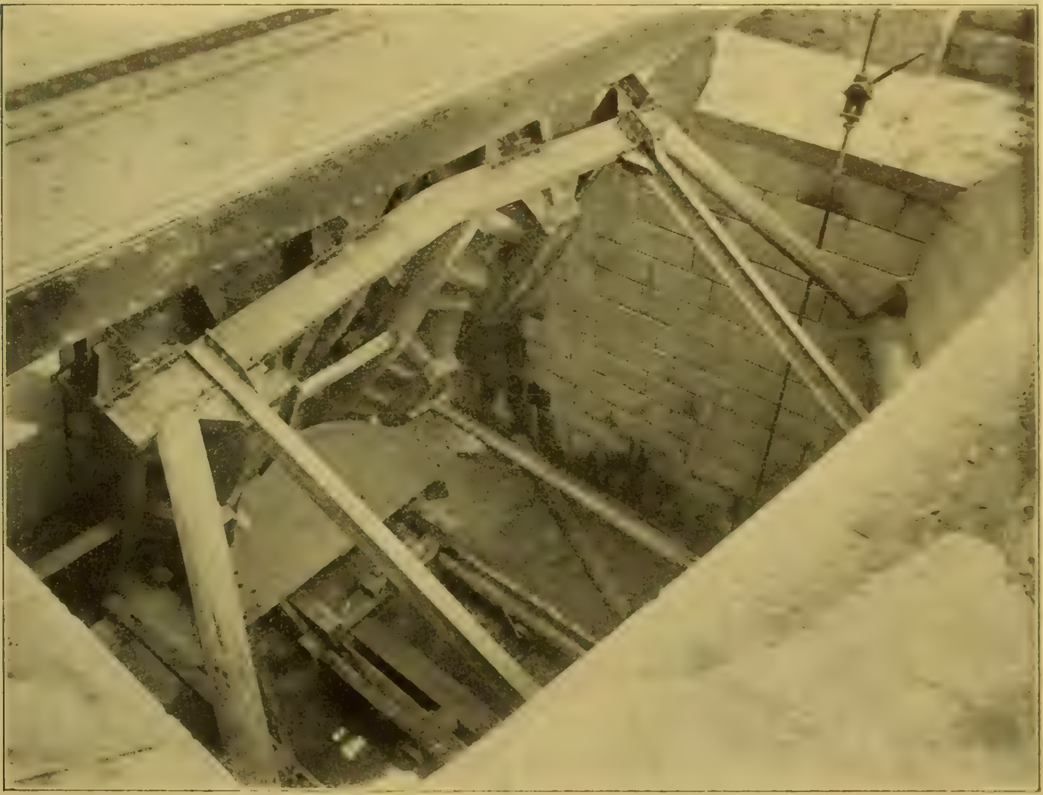
THE EYE-BAR CHAINS COMPLETE, AND CONSTRUCTION OF THE FLOOR UNDER WAY.



ASSEMBLING THE EYE-BAR LINKS IMMEDIATELY ABOVE ONE OF THE ANCHORAGES.

cross braces. Permanent access to the ends of the chains is provided, so that their preservation may be observed. Above these chambers are situated the offices of the *octroi*.

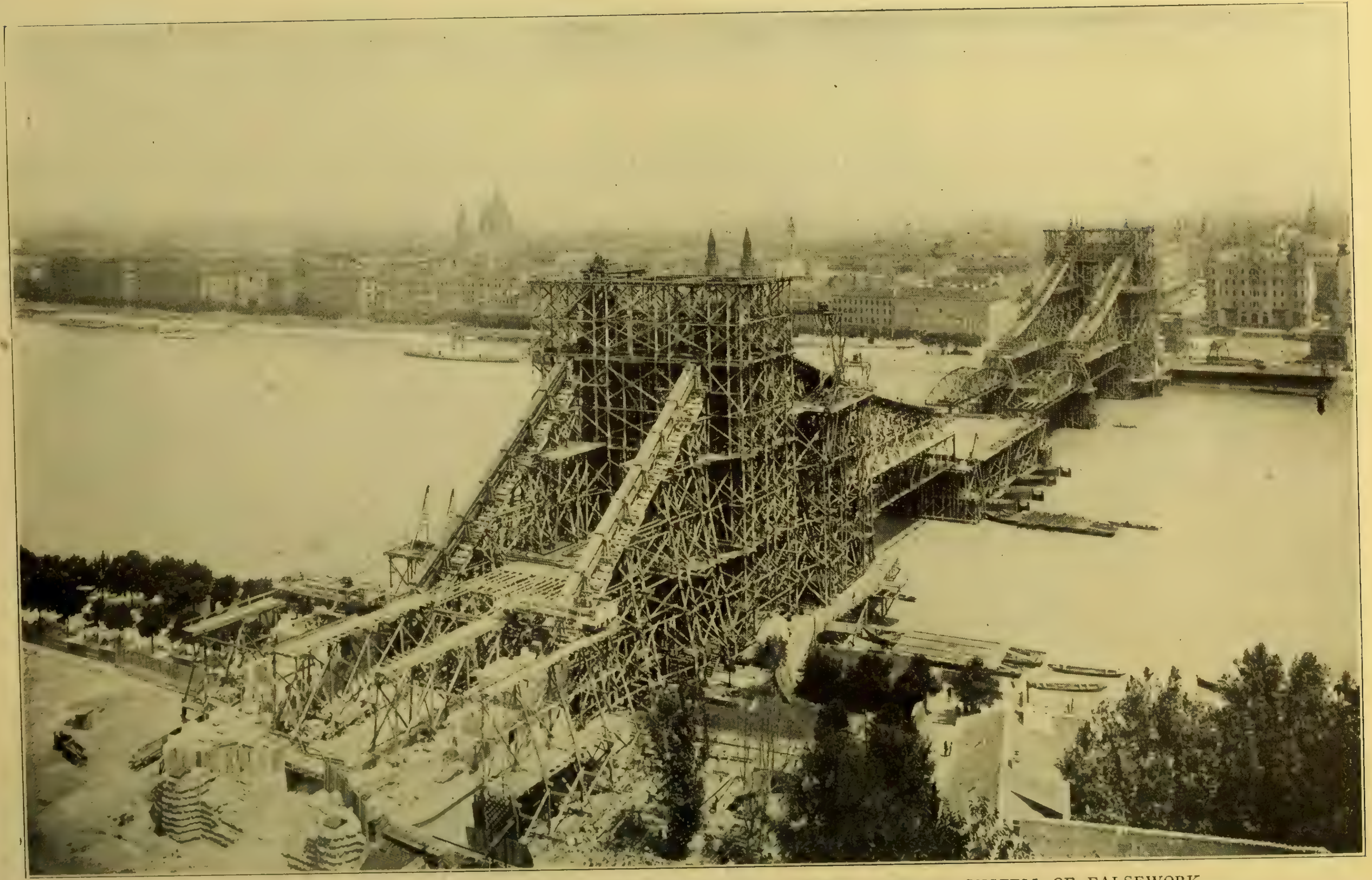
The eye-bars are made of steel plate, 15 to 25 millimetres thick, 40 to 90 centimetres wide, and assembled in parallel groups of 19 or 20 to form a section of the chain. The length of these sections varies, being in the case of some as great as 15 metres, but diminishing from the ends of the chain towards the middle. At the center of the long span the width of the body of the links is 40 centimetres and that of the head 72 centimetres. The suspenders are fastened at the joints of the chain, and hung from the same pins which connect the links. The entire system comprises 200 sections, weighing 4,270 metric tons.



THE ANCHORED END OF THE EYE-BAR CHAIN.

View looking into the permanent chamber left in the anchorage masonry, for inspection of the steel sole plate and the ends of the links.

The machining of these steel plates, of considerable size, and the necessity of the exact adjustment of each one to its position, imposed difficulties which were very happily surmounted. Instead of forging up, at each end of the plate or bar, the mass of metal necessary for the dimensions of the head, and then boring the eyes (as is frequently done in American shops), it was thought preferable to cut each link



THE EYE-BAR CHAINS APPROACHING COMPLETION, SHOWING THE ELABORATE SYSTEM OF FALSEWORK.

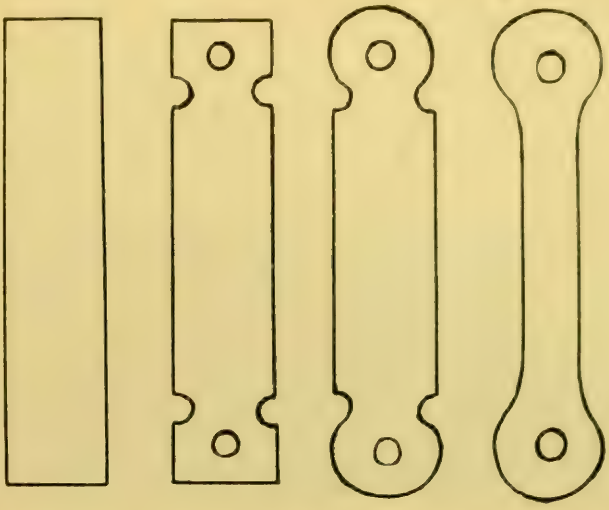


DIAGRAM ILLUSTRATING SUCCESSIVE STEPS IN THE MAKING OF A SINGLE EYE-BAR.

from a rectangular piece larger than the template. The loss of metal, it is true, was 40 per cent, but the gain was accuracy of work and greater certainty as to the tensile strength. The diagram shows the successive steps in the operation.

The mild steel used had a tensile strength of 55 kilogrammes per square millimetre (78,270 pounds per square inch) and a minimum elongation of 20 per cent. In the manufacture of the eye-bar links, the removal of metal was effected entirely by cutting, carefully avoiding any punching or shearing with the attendant necessity of an annealing which would have caused uncertainty as to the metal's retention of its original qualities. The planing, boring, and reaming machines used for the work were specially designed.

As each section of the chain required the assemblage of 38 to 40 links on a single axis, each link had to be rigorously accurate in its dimensions. In furtherance of this requirement, and to reduce to a minimum errors due to variation of temperature, all templates and gauges used on the job were made from the same steel as the eye-bars, and so far as possible, under similar conditions.

Particular care was used to avoid deformation of the links during handling in the shop or transportation between operations. The handling was accomplished by the aid of long girders, with holding clamps, supporting each piece uniformly throughout its whole length.

The removal of the metal from each blank, in the preparation of the single links, was effected by a pair of machines, working simultaneously on the two ends, cutting away a shoulder behind the head and boring the eye at the same time. A double-headed planer then cut away the remaining excess width along the body of the link: the several links of a section were assembled temporarily, and the finish-boring of all the holes of a single axis was accomplished at one operation. The diameter of these eyes varied from 30 to 50 centimetres.

The axes or pins, of varying diameter corresponding to that of the eyes, were forged from steel similar to that used in the links. Their

THE PANORAMA OF THE DANUBE AT BUDAPEST.

The Elizabeth Bridge is in the foreground, and the old suspension bridge next beyond.

length depended upon their position in the chain. The nuts were of cast steel.

The total length of the upper chain, comprising 4,094 eye-bars, is 525.5 metres. The manufacture of the elements alone required 21 months, covering 571,000 working days of 10 hours each. This manufacture was carried on, after data fixed by the National department of bridges, in a specially constructed workshop in Hungary. In spite of the great expense (710 francs per ton of chain) necessitated by the precise methods followed, the possibility which they presented of building up both chains simultaneously, at a point remote from the bridge itself but at the same time that construction of the piers and approaches was going on, was considered sufficient reason for preferring the chain to the wire-cable type. This advantage was especially marked here, seeing that the bridge was of large dimensions, that it was desirable to hasten its completion, and that the immediate neighborhood was much encumbered. The building up in place of cables of equal strength would of itself have presented great difficulties.

Foundations and Abutments.—The excavation for the foundations was commenced, with the aid of compressed air, in 1899, and carried to a depth of 9.10 metres below datum on the Pest side and of 5.50 metres on the opposite bank. Two caissons 19 by 9 metres were used for sinking each pier. The abutments were more difficult of construction on account of the critical importance of the anchorage foundations; it was determined to place these upon concrete beds, capped with asphalt, and laid continuously at each bridge approach

THE PANORAMA OF THE DANUBE AT BUDAPEST.

Completing the view on the opposite page. The Francis-Joseph Bridge is in the foreground.

so as to avoid cracks. The work was done within a sheet-piling enclosure re-enforced with metallic braces. Inflows of water impeded the work at various points until the channels in the sub-soil by which they gained entrance were successfully concreted. The plan adopted, as we shall see further on, involved certain dangers due to the character of the sub-soil, and these eventually became evident.

Outside of the concrete portion, the masonry is of granite. The parts beneath and around the anchorage chambers were first constructed; then the anchorage sole-plates were placed in position and blocked up on temporary supports while the masonry was built up to them. The stonework was carried forward progressively as the lower portions of the chain were assembled in place. To maintain the links or eye-bars of the lowest section at their proper distance apart, "washers" or blanks of proper form were introduced.

The erection of the bridge did not begin until the spring of 1902; it was effected with the aid of huge scaffoldings, which left, in the width of the river, four openings of about 50 metres each. The false work was taken down at the beginning of winter, as there was danger of its being carried away by ice in the heavy current running at that season. The chains were already in place, and the work was continued without interruption, using them as support and building out the floor from both banks.

The erection had been in progress for some time when there became apparent, at one end of the bridge, a slight but discernible sliding of the anchorage foundation. It was discovered that the asphalt cap of the concrete foundation, raised to a high temperature

WORK ON THE ANCHORAGE, AND THE SHORT SHORE-SPAN APPROACHES.

by subterranean flow from hot springs, was the cause of this movement. In addition to temporary measures for supporting and lightening the suspended structure, a supplementary foundation was placed in front of the threatened one, and bonded into it and into the ground with heavy buttresses which held the whole together. Further, pig-iron ballast and foundations for the bases of statues not yet installed added their weight to that of the main foundation, to oppose any possible tilting upon the toe under the pull of the chains.

Tests under load did not show any further movement. On the other hand, a temperature rise of 10 degrees caused the floor of the bridge to drop 83 millimetres at the middle of the span. The oscillatory movement of the towers under the extreme range of temperature experienced are inconsiderable—only 2 or 3 centimetres.

The total weight of metal in the bridge is 11,170 tons, or nearly 30 tons (metric) per metre of length.

A QUARTER-CENTURY OF ELECTRIC RAILROADING.

By Franz Koester.

In our preceding issue, Dr. Bell discussed most instructively the latest development in electric traction—the application of single-phase alternating current. In this connection it may be of value to run over, in brief survey, the successive steps of the wonderfully rapid progress made in perfecting the electric railway and adapting it to a most important service in the economy of modern life.—The Editors.

TWENTY-FIVE years only have elapsed since the introduction of electric railroading, but during this time enormous progress has been made in this branch of engineering. The greatest development in this field however has taken place within the Twentieth Century. This may be due to a large extent to the fact that railroad engineers did not sufficiently realize the benefits to be derived from this system, and hence the development devolved almost entirely upon the electrical engineers.

Electric railroading, during the first two decades of its existence, was carried on in such limited fields that the system was either the ordinary direct current, or storage battery mounted on the cars. During the latter part of the nineties the combined alternating- and direct-current system appeared, while in the last five years the three-phase alternating was successfully introduced; and, finally, the marked progress of the single-phase system has developed only in the last two years. All these systems have been employed under various conditions, with more or less success, both for city and interurban freight and passenger service. Each system has its own advantages and supporters.

The first electrically drawn train was put in operation at the Berlin Exposition in 1879, (Figure 1) as constructed by the Siemens and Halske Co. of Berlin. This, however, was only a miniature model, while the first practical, commercial electric railway was that in Lichterfelde, near Berlin, put in operation, (also by the Siemens Co.) in 1881. Therefore the honor of the first commercial electric railroad belongs to Germany.

This road was 2.5 kilometres long, had a gauge of one metre, and operated at a potential of 160 volts delivered through the rails. The

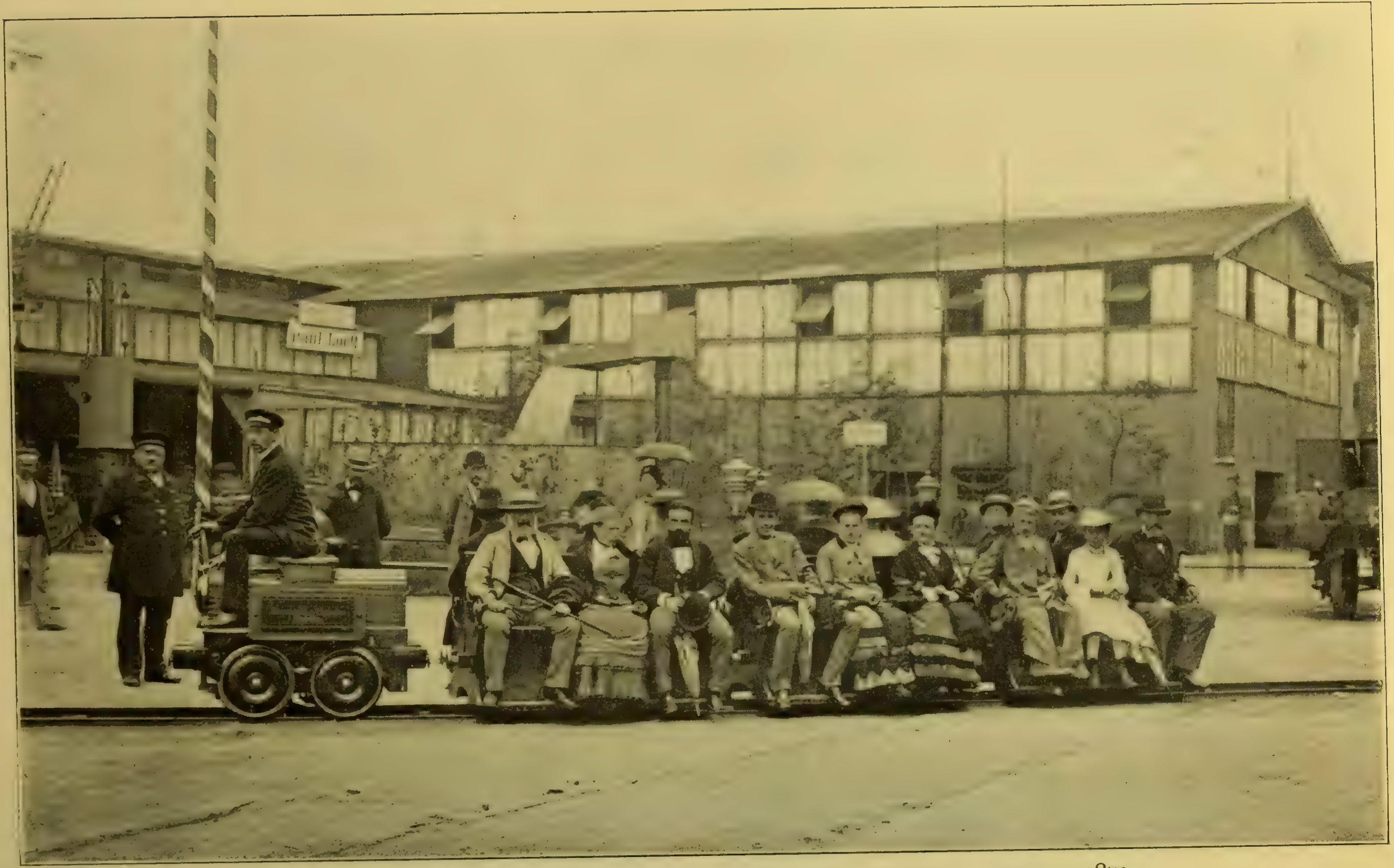


FIG. I. THE FIRST PUBLIC UNDERTAKING IN ELECTRIC TRACTION. BERLIN, 1879.

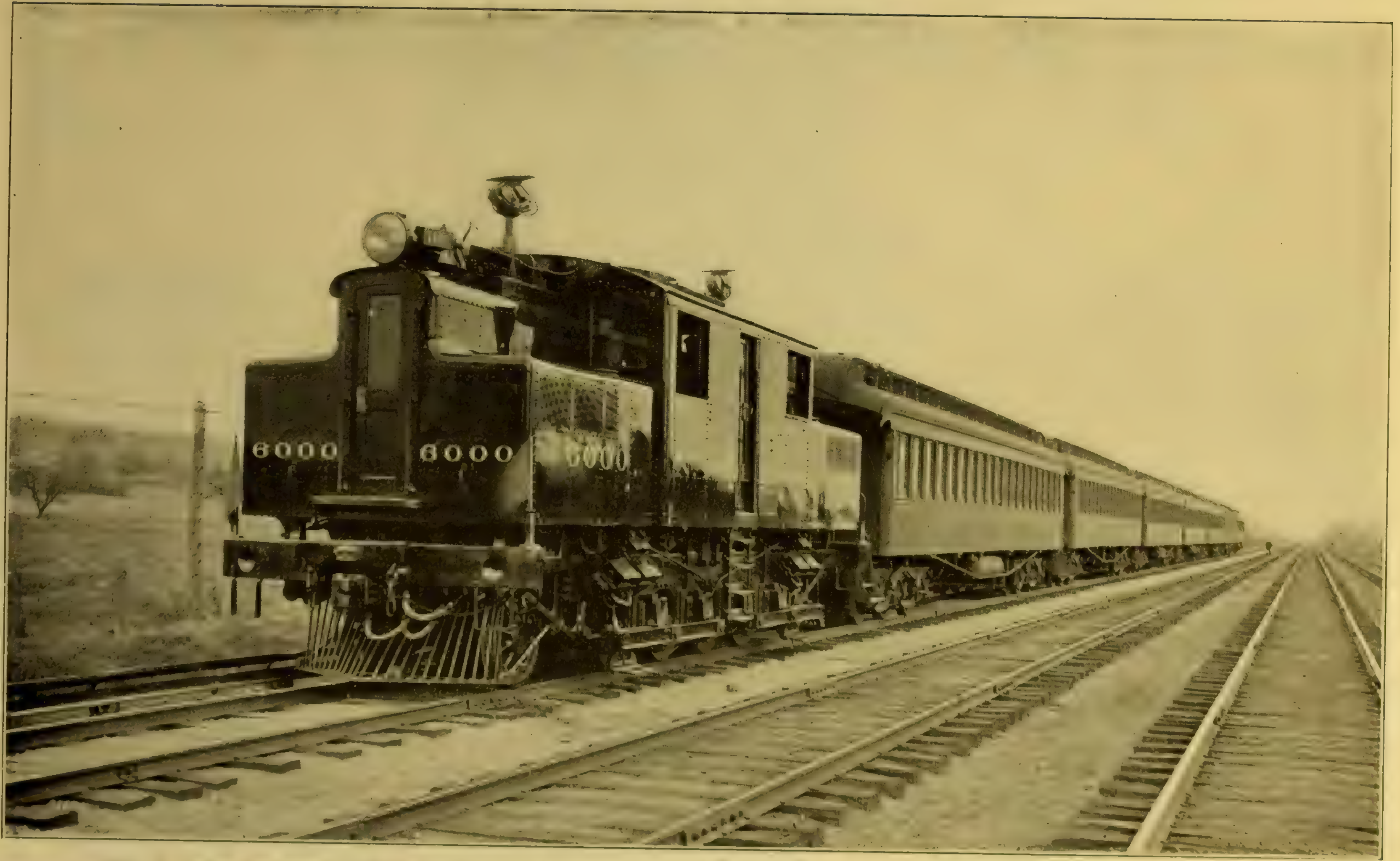


FIG. 2. ONE OF THE LATEST ELECTRIC LOCOMOTIVES. NEW EQUIPMENT OF THE NEW YORK CENTRAL RAILWAY.
Built by the General Electric Co., Schenectady, N. Y.

rolling stock consisted of three motor cars (Figure 3), each equipped with a single ten-horse-power motor. Each car had a capacity for ten passengers. Two years later, in 1883, the installation of the road between Mödling and Hinterbrühl near Vienna followed. This road was 6 kilometres long and had the same gauge as the former, but instead of conducting the current through the rails an overhead system was adopted, consisting of two slotted pipes, supported by catenary suspension, similar to the present practice in single-phase railroading, (Figure 4). Current was taken by means of carriages drawn along these pipes by flexible couplings. This was soon followed in the same year by the installation of the Portrush road, of the Giants Causeway and Portrush Tramway Co., operating on the third-rail system, and also by various other equipments.

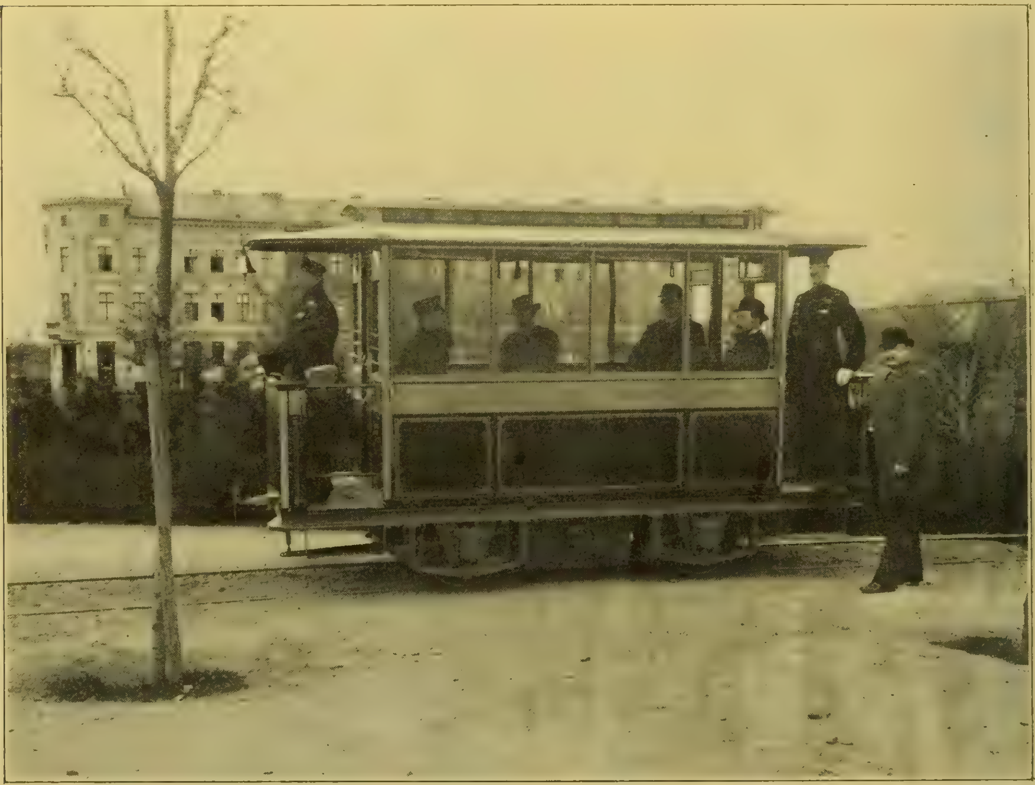


FIG. 3. AN EARLY COMMERCIAL ELECTRIC RAILWAY; LICHTERFELDE, NEAR BERLIN, 1881.

After having operated several experimental electric roads in America, the first commercial road was installed in 1886 near Baltimore (Figure 5).

As time elapsed various roads were built, up to the year 1889, when in the city of Budapest the first underground-trolley system was installed. This system was so designed that the slot formed part of one of the running rails, as in the later built roads of Berlin and

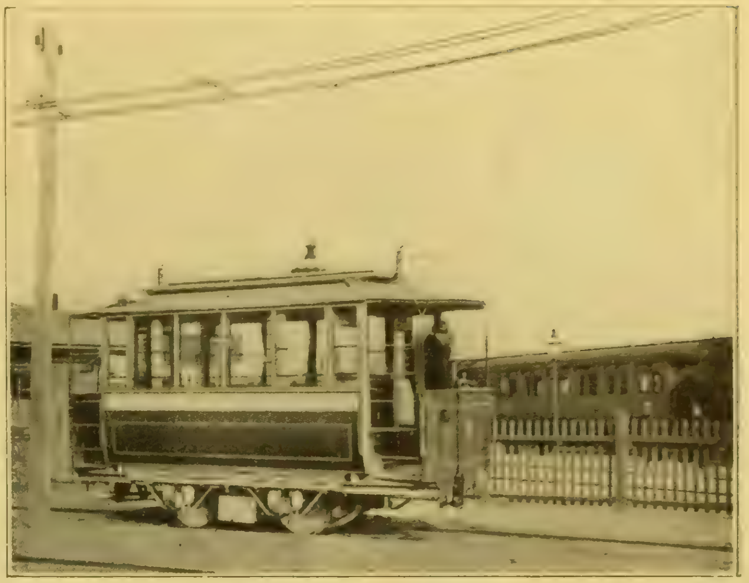


FIG. 4. ONE OF THE FIRST OVERHEAD TROLLEY CARS.
Mödling, near Vienna.

other European cities. This road (still in operation) was twenty miles in length, partly overhead and partly underground construction. The underground sections were adopted, in spite of the excessive cost, on account of the desirability of not disfiguring the more prominent part of the city with overhead wires; thus the equipment of the cars with both underground shoes and overhead-trolley poles was necessary.

In the year 1890 the first underground electric road, (subway) some six miles long, was put in operation in London, England. The rolling stock consisted of fifty-two locomotives (Figure 6), each provided with two motors supplied with current at a potential of 500 volts, by means of a third rail. Up to 1900 many prominent electric railroads were installed, the details of which however are without the province of this article. The greatest step in electric railroading was taken with the introduction of the alternating current, practically at the beginning of this century, thus making

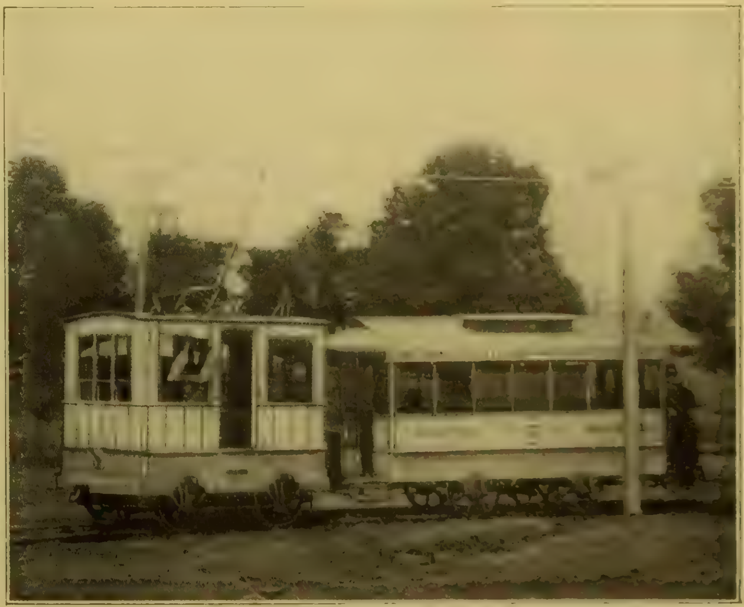


FIG. 5. A PIONEER COMMERCIAL ELECTRIC RAILWAY OF AMERICA, BALTIMORE, 1886.

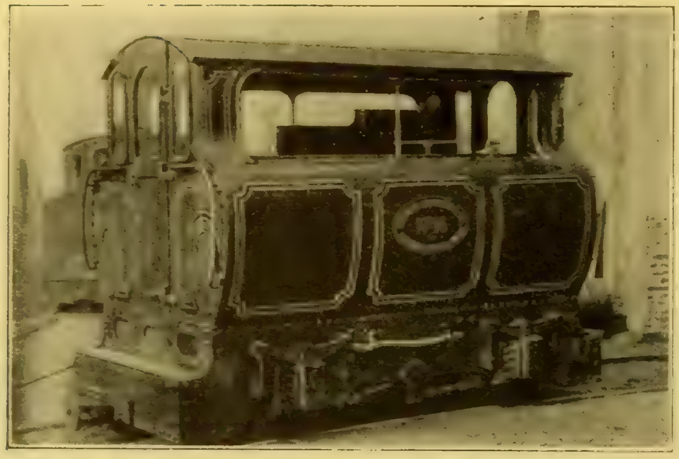


FIG. 6. ELECTRIC LOCOMOTIVE OF THE LONDON SUBWAY, 1890.

Siemens Bros. & Co.

feasible long-distance transmission. The first type of this system (as with the many still in use) consisted of a main central station where the alternating current is generated, and rotary-converter substations, transforming the current for use with the direct-current railway motors. Many such roads have been erected on both sides of the Atlantic and operate in city districts as well as under interurban service.

Under this class might be mentioned, the newly installed New York Subway, the great municipal railway system of Vienna—where in the entire city no horse car at present exists—and the Berlin Elevated and Underground Road; a number of prominent steam roads

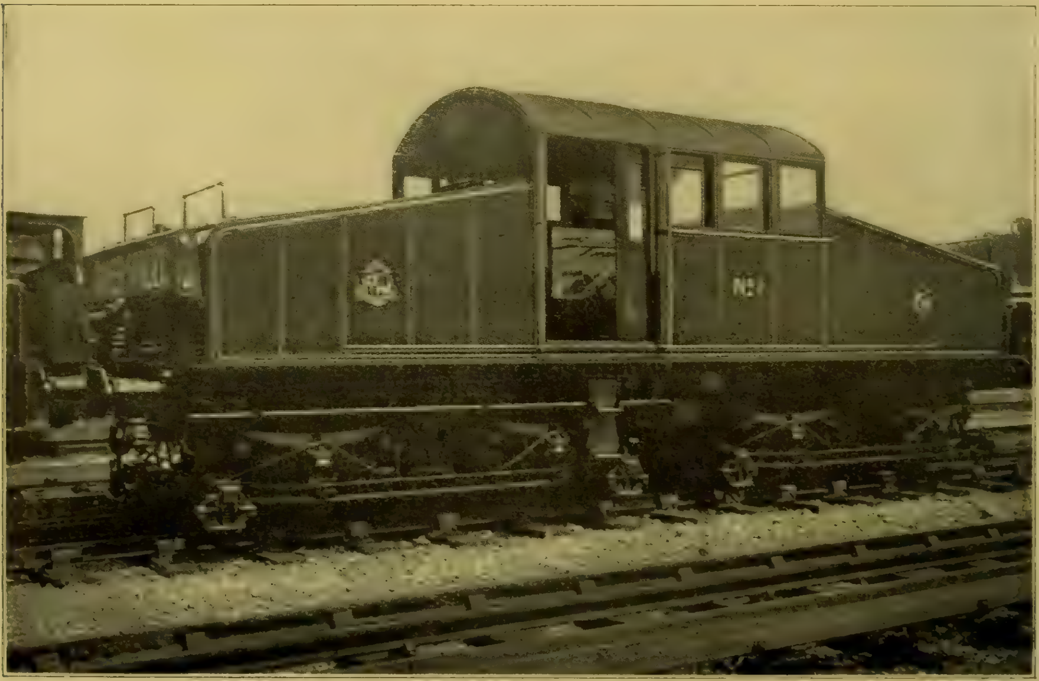


FIG. 7. ONE OF THE 150-TON ELECTRIC LOCOMOTIVES FOR THE LONDON METROPOLITAN RAILWAY.

Built by the British Westinghouse Co.

also have been thus electrified, such as the Chicago and Manhattan Elevated Roads, and (now under course of construction) a part of the Great Western Railroad near London (Figure 7), part of the New York Central and Hudson River Railroad (Figure 2), and part of the Pennsylvania. The locomotive represented in Figure 7 is equipped with four 200-horse-power motors which may develop an aggregate of 1,000 horse-power. This locomotive is capable of hauling a passenger train of 170 tons at a speed of 36 miles per hour while freight trains of 250 tons may be run at 27 miles.

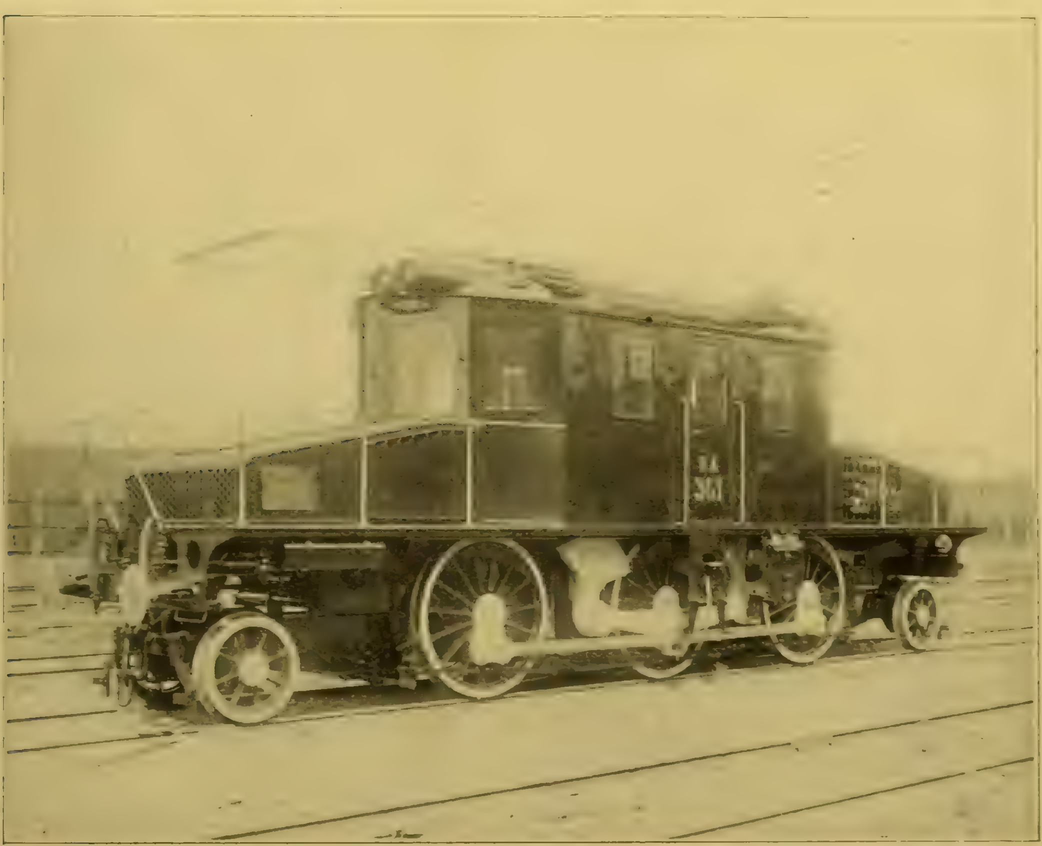


FIG. 8. NEW ELECTRIC RAILWAY LOCOMOTIVE OF THE VALTELLINA ROAD, ITALY.

Built by Ganz & Co., Budapest.

More prominent, and undoubtedly involving greater engineering skill, is the Valtellina Road of Italy, sixty miles in length, equipped by Ganz and Co. of Budapest, with their three-phase alternating system. Although this road and the system have been fully described in the technical press on both sides of the Atlantic, an illustration of the new type of locomotive as put in operation in 1905 will be of interest. This locomotive differs from the original type furnished with the equipment of the road some four years ago, in the arrangement of the motors with respect to the drivers. In the older type of

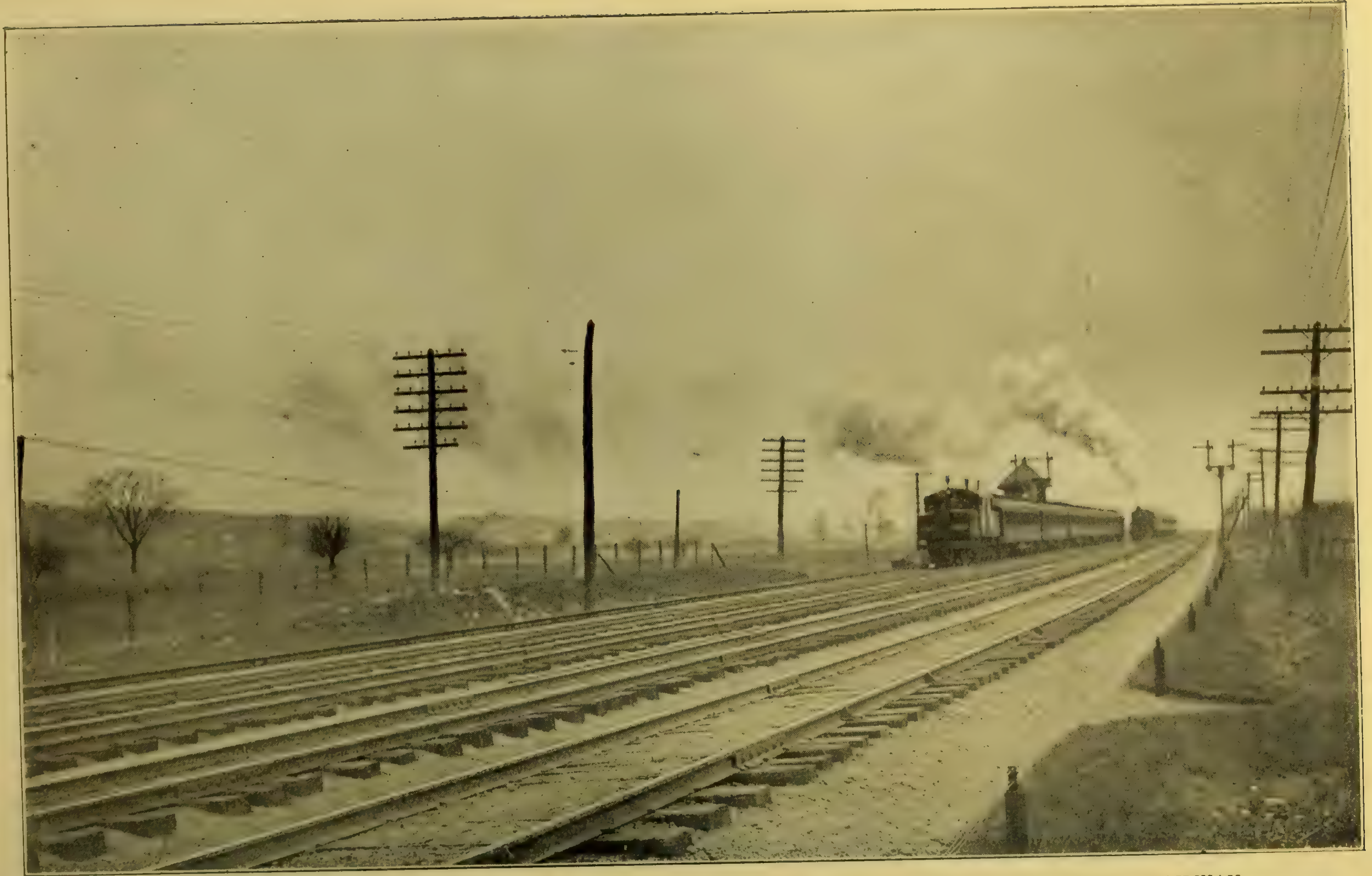


FIG. 9. SPEED TEST BETWEEN ELECTRIC AND STEAM LOCOMOTIVES ON THE NEW YORK CENTRAL RAILWAY.

locomotive the motors were mounted on hollow shafts surrounding the axles of the four pairs of drivers, the latter being connected to the rotors by means of links; while in the new type the motors are arranged between the three pairs of drivers, each motor axle bearing a combined high-and low-tension motor which before were spread over two driver axles. The system of connecting rods is clearly shown in the accompanying illustration (Figure 8).

Among other lines using the three-phase system may be mentioned the Jungfrau Railway, still under course of construction. On account of the magnitude of the undertaking this line is being built in sections and trains are operated over that part which is completed—at the present writing, up to the Eismeer Station. It will be some time before the peak, 13,665 feet above sea level, is reached. Locomotives of both the Oerlikon and Brown-Boveri type are used on this two-wire overhead system, the rail acting as the third conductor.

Another Swiss three-phase railroad will be put in operation, probably in the early part of this spring. It is that of the Simplon Tunnel, being the longest of its kind in the world. The system is that of the Ganz company, 15 cycles, 3,000 volts at the trolley wire. Another Ganz three-phase system is still under course of construction in Canada, between London and Port Stanley, a distance of about 27 miles.

Among the continuous-current roads, generally operating at a low potential, the 1,200-volt road in the coal-mine district of La Mure, in Southern France, is worthy of note. The locomotives are equipped with four 150-horse-power motors, a sliding bow being provided for each, taking current from one of the two overhead trolleys. This road was installed by the Compagnie de l'Industrie Electrique et Mécanique, well-known on account of various experiments with high-tension continuous current.

The newest addition in electric railroading is the introduction of the single-phase system, simultaneously in America and Europe, although on the Continent the roads were actually in operation several months earlier. For example there are the Murnau-Oberammergau Road connecting the Bavaria State Railway with the village of Oberammergau, world-renowned for its passion play. This road was, in 1904, some 14 miles long, operating at a potential of 5,500 volts and 17 cycles. The cars are equipped with two 80-horse-power motors. For carrying the overhead trolleys, span wires mounted on insulators are used, except that for a length of about one mile the catenary system is installed. The equipment is by the Siemens-Schuckert Co. of Nuremberg. Another line frequently mentioned in the technical press is that in Spindlersfeld, near Berlin, which was actually an experimental line some 2½ miles long, installed and operated by the Allgemeine Electricitäts Gesellschaft of Berlin. The trolley is fed at a potential of 6,600 volts at 25 cycles. The cars are equipped with two 110-horse-power Winter-Eichberg motors. As this road has, since 1903, been operated as an experimental line, much valuable knowledge has been obtained from it.

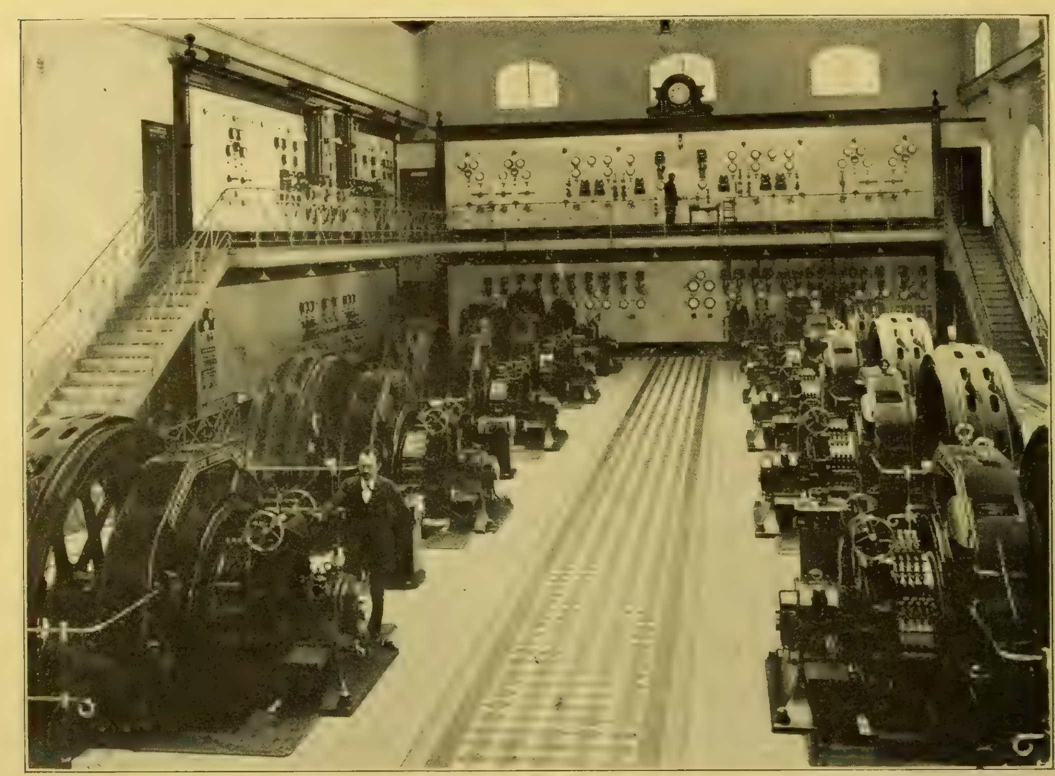


FIG. 10. A TYPICAL MODERN CONTINENTAL STREET RAILWAY SUB-STATION, VIENNA RAILWAY SYSTEM.

Another most important road is that of the Stubaithal in the Tyrolean Alps, running from the capital Innsbruck to the resort Fulpmes, some eleven miles, put in operation by the Allgemeine Electrictäts Gesellschaft in 1904. The trolley voltage is 2,700, at a frequency of 42 cycles per second. These cars are equipped with four 40-horse-power Winter-Eichberg motors. Another road is the Borinage-Vicinaux in Belgium, near Mons, a line some 8½ miles in length, operating at a potential of 600 volts, 40 cycles. Another very important single-phase road is that between Rome and Pont Milvio, Italy, 33 miles long, installed by the Westinghouse Company. For a length of 2½ miles the trolley electromotive force is 550 volts, while for most of the remaining part it is 6,600 volts, impressed directly upon the trolley wire. By means of main transformers mounted on the cars the current is stepped down to 250 volts for which the motors are wound. Another road is that of Baden and Vienna, some 15 miles long, installed by the Siemens-Schuckert Co. A very interesting single-phase railway system development is that of the Oerlikon Company, a notable feature of which is the use of the Huber current-collecting device.

The single-phase system, although extremely new, has shown very marked progress which naturally must be due to many advantages, one of the very important ones being the elimination of rotary sub-stations. The expense of the alternating-direct-current sub-station may be judged from the accompanying illustration. Figure 10 represents the sub-station Mariahilf of the Vienna Railway System, as designed and installed by the Siemens-Schuckert Co., while Figure 11 shows a sub-station of the Philadelphia Rapid Transit Co. Railway System, as installed by the Westinghouse Electric and Manufacturing

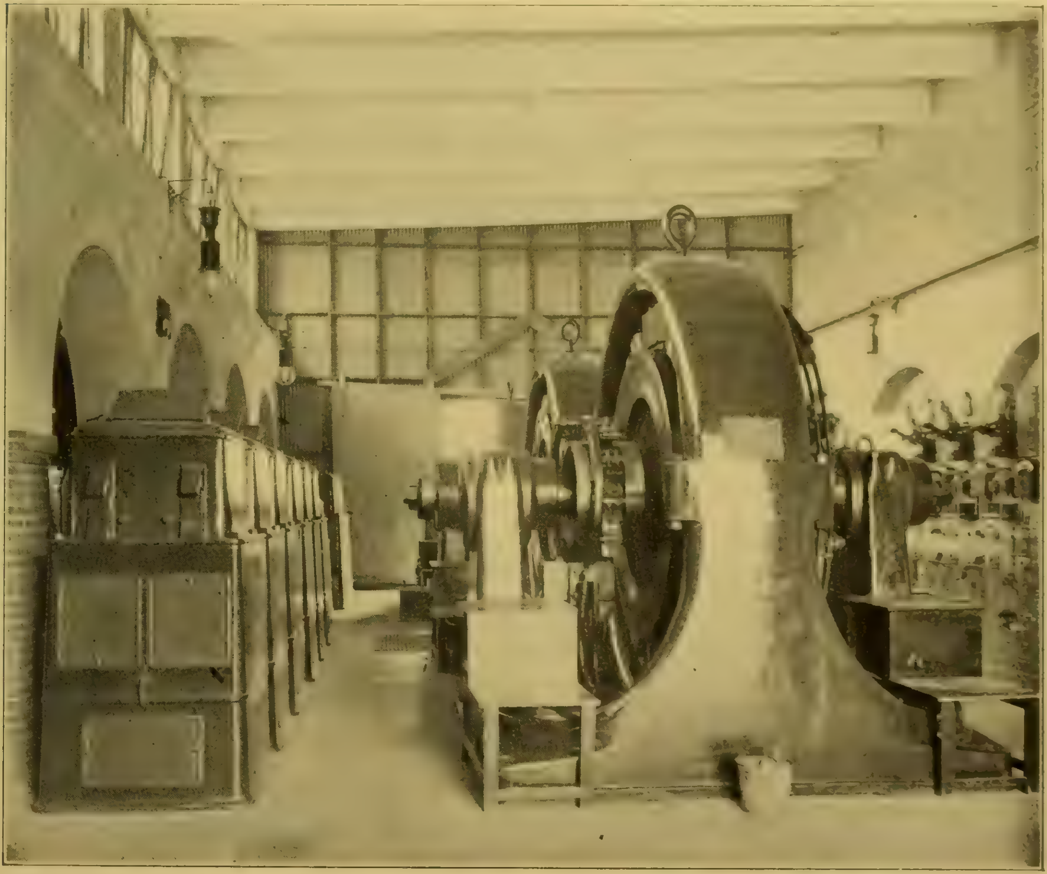


FIG. 11. A TYPICAL MODERN AMERICAN STREET RAILWAY SUB-STATION.

Philadelphia Rapid-Transit Co., 52nd St. and Lancaster Ave.

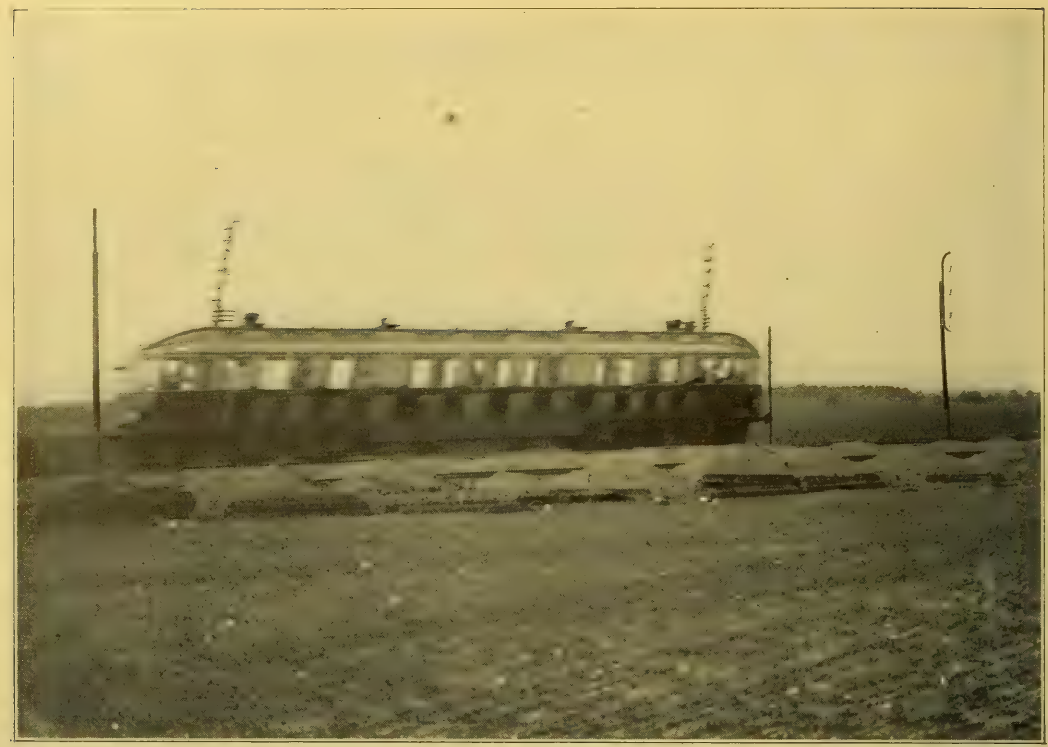


FIG. 12. ELECTRIC CAR MAKING 125 MILES AN HOUR.

In the tests of Siemens-Halske equipment on the Marienfeld-Zossen Line. The deformation of the image shows the motion during the very brief opening of the shutter.

Co. Both illustrations represent typical modern railway sub-stations of their respective countries.

The magnitude of the advancement during the life of electric railroading (twenty-five years) is probably best realized by comparing the first cars put in operation with the photographs made at recent high-speed tests. In Figure 12 we have the Siemens-Halske car running at a speed of 125 miles per hour. As every reader will well remember, the highest speed was obtained in the tests of 1903, 131.4 miles per hour, on the Marienfeld-Zossen road near Berlin. Figure 9 represents the General Electric Co.'s electric locomotive in a competition test with a N. Y. C. & H. R. R. Co. steam locomotive, both drawing trains made up of six cars—a total train weight of (electric) 407.5 tons and (steam) 427 tons. The maximum speed developed in this run was approximately 57 miles per hour (the electric locomotive being about one train length ahead at the end of 1,500 feet on account of the rapid acceleration) while the same electric locomotive running light has reached a speed of 85 miles per hour.

THE CHANGES OF ONE LIFETIME IN THE MACHINE SHOP.

By Egbert P. Watson.

LOOKING backward over half a century of intimate acquaintance with machine work in various branches—active, personal participation, as a means of livelihood—I can see many milestones marking the progress made in machine tools, and in the methods of doing work. An experience of that length runs back to the time when there were but few tools, and those of the rudest character as compared with the splendid machines for all purposes that are weekly illustrated in technical journals; and, although not quite in "the sere and yellow leaf," I thoroughly appreciate the differences between this day and that of the olden time when metals had to be dressed to dimensions by the hammer and chisel and file. To be a "machinist" capable of all around good work then meant much more than it does today, when any man who has attended a special machine for a few years lays claim to that title, though he can not prove his right to it when put upon any job that comes along. I have also, during the period mentioned, seen many ambitious projects, which were to revolutionize this or that method or machine, put to flight and abandoned because they were mechanically impossible. These schemes were abandoned at that time only because the devisers of them could not make the thing go, for one reason or another; but this has not deterred latter-day experimenters from investing in them, in the full faith that they have at last discovered a mechanical philosopher's stone that would transmute base metals into gold.

The materials that pioneer engineers had to deal with were iron and steel chiefly—but what kind of iron and steel? By no means that in market today. The iron was either red- or cold-short usually, and crudely rolled to some size not on any rule. The squares would be ¾-inch, one way by ⅞-inch the other way (so it could be sold for either size, the boss blacksmith used to say) while the rounds were more oval than any other shape, and the flats left much to be desired. A quick way of testing for quality was to strike a bar over the horn of an anvil; if it broke short, it was bad, but if it could be bent cold and drawn to a fine point without splitting it passed as "pretty good iron."

There were irons of unquestionable merit—"Sligo" for one, "Salisbury" for another, and "Lowmoor"—but the last was too high-priced for general use; as much as 14 cents a pound sometimes. There were also Swedish and Norway irons, but they were used only where it was not safe to take any chances; and as for steel it was, as a rule, not used except for tools, springs, or valve stems. The popular view of it was that it was brittle and unreliable for sudden strains.

Machinery steel, as we now know it, was unheard of; the only way to employ steel was to anneal it several times, in wood ashes or spent lime from gas-house retorts, or by heating it to dull red in the dark and then quenching it in cold water. After such treatment it would sometimes be soft enough to work in machine tools, but full of pin spots that a file would not touch. For cutting tools it was generally stubborn and perverse; sometimes it would temper without trouble, but at others neither fire nor water would avail to make it endure. This was English steel of various brands, for American tool steel was only in the experimental stage and it was a long time before it got past it.

Forgings in 1845-50 were as a rule of excellent workmanship, close to sizes on drawings and in any desired form; cranked shafts were then as now forged solid as to their webs, and afterward slotted out—when there was such a machine as a slotter in the shop; for the most part there was none. Then the throw was drilled out and chipped for the crank-pin. All this is of the past now, for special machines finish the crank-shaft complete for almost what the forging cost fifty years ago. Forgings fifty years ago were for the most part (when of any size) flogged out of the stock by strikers with 20- and 25-pound sledges; steam hammers were few and far between, and even tilt or trip hammers were not common, except in tool shops where there was constant use for them. As late as 1875 large shafts for marine engines—shafts 18 inches in diameter—were made in New York city "by hand," so to call it; billets made from selected scrap were first welded to about 4 by 3 inches by 24 inches long and then welded on to a porter bar, and continually added, one on top of the other, until the desired size and length were attained. No one of these shafts ever broke through defects.

Prior to the time I began my apprenticeship to the machine business in 1851, marine engineers were greatly troubled with the shaft question when higher-powered engines came into use. Cast iron was used for some of them, but, as might be supposed, it soon showed its unfitness for the strain, and some shafts were made from iron bars about 1 or 1½ inches square, in bundles, laid up to the required diameter and "skin-welded," so to call it, exteriorly—evidently by sledges, since there were no power hammers that could do the work. I saw one such shaft taken out of a river steamer, the Mountaineer, that had broken short off, and the square bars were plainly in evidence, welded for about an inch deep exteriorly; that was the last experiment in that direction. Then shafts made from boiler plates were tried, riveted up in sections just as vertical boilers are. A steamer called the New Globe, I think, ran on the Hudson river with such a shaft for many years; as I now recall it the diameter was about 18 inches, and when running it rang like a bell.

It was not the shafts alone which gave trouble by breaking, but the cranks as well. These could be cast and afterward reinforced by wrought iron bands shrunk around them; these bands were 2-inch square iron, and two of them passing around the crank from top to bottom made the casting as strong as a forging, apparently. I never knew one of them to break, except one that had been cast for a long time and laid out doors as a spare some years, no one knew how long. One day it exploded with a noise like a six-pounder, rent from top to bottom by some internal strain which time had not removed. But the engines increased in power, and cast-iron cranks had to give way to wrought-iron; huge forgings these were, some four feet across the shaft hub, weighing four tons each. The hole for the shaft was bored out of the solid by an immense drilling machine which stood 30 feet high and was called the "giraffe"; this was the progenitor of heavy machine tools, and it well fulfilled its task. The spindle was 12 inches in diameter, and had a tool carrier on its end which held channeling tools that soon removed a solid cylinder, leaving a hole which was afterward bored true and faced on the hub, so that the crank was finished complete without going into a lathe. Radial drills now do the same thing that this vertical drill of half a century ago did, with the additional convenience of a longer radius of action.

It should not be assumed, therefore that there were no machine tools of any importance fifty years ago in use in the United States, for that would be quite wide of the facts. There were large planers, capable of taking castings 6 feet wide by the same height, and 20 feet long; also lathes which would handle steamboat shafts of 30-tons weight and swing a flywheel 20-feet diameter. Some of these lathes were triple-geared, and driven by round raw-hide belts about an inch in diameter, which ran at a very high speed, so that our forebears were by no means ignorant of the fact that increasing the speed of a belt added to its efficiency. I have seen an intermediate shaft for a large oscillating engine, which (the shaft) was built up of the several members by shrinking them together; all assembled, the shaft was put into the lathe and each bearing turned on its own centers, so that there was no possibility of the bearings being out of parallelism with the others. As the bearings were very large and the cranks 4 feet from center to center, the net weight was much over 40 tons, including the necessary counterbalances, but the lathe walked away with the load all right, except for a little trembling all over, and that would be a job for the best machine tool of its class today.

The shop of which I have been speaking had been in existence for twenty-five years when I entered it, so many of the tools in the finishing shop had been made in 1835, and for that matter much before it; some of the lathes particularly had wooden shears for beds, plated on top where the carriage ran with iron about 3 inches by ¼ inch thick; these lathes were exclusively for hand tools, as there was no slide rest, or carriage—simply the common rest for hand tools, but excellent work was done upon them for all that. For many years after I entered the shop all the poppet valves and their stems, 1½ inch diameter by 36 inches long, having a thread chased on one end for 10 inches or so, of about 8 pitch, were turned up on these hand lathes, and those who have never done such work cannot appreciate the manual skill it requires to execute such jobs, day in day out, without spoiling some of them. Be it known to those of the present generation who may chance to read this that it requires a high quality of manual dexterity to chase a thread of about 6 pitch on a steel shaft, and keep it true for about 10 inches without having it "drunken" in some part of its length, but this is what an old-time machinist did, year in year out, without fault; there was never a bad job, but every one was absolutely correct to dimension and fit. There were screw-cutting lathes in the shop at that time, but they were not used on the work in question, because the hand-tool man could do the work better and just as quickly. The same is true of a good deal of heavy planer work; rather than get the gang of laborers to truck the work some distance to the tool, hoist it onto it, and bring the job back when it was done, a force of chippers would attack it and soon complete it; but there were chippers in those days who were expert in their line—they have passed away because modern facilities in the way of electric cranes, and pneumatic tools have dispensed with their services. In one shop where I was at the period named they had a "Jim Crow" planer, so-called because it took a cut on both travels of the bed, going and coming back; but it was not a success, except upon a finishing cut with a broad-faced tool. The tool post revolved in a box by means of a round belt with a stop on one side of the box to bring the tool into position for the reverse cut, but the tool bounced when it struck the stop and stood nowhere, so the roughing cut was double or treble what it should have been, and stalled the machine.

The first attempt to mill surfaces by rotary cutters that I am cognizant of was made by a machine called a "slabber," which dressed up hexagon nuts strung on a vertical mandrel, doing two sides of the nuts at once, and it was a vast improvement on the chipping and filing methods which had preceded it. This was, I have always thought, the genesis of the present milling machine, for the reason that this tool was unknown in the trade at that day, and for many years afterward.

There were some planing machines which were unique of their kind, being operated by a chain in lieu of rack and pinion, or a screw —and when they reversed motion the attendant knew it, for it would jar him off of his feet, if he was not on the watch for it. The small lathes in the finishing shop, 14 and 26 inch, left much to be desired in construction and operation, being so light in body that they trembled all over with a very ordinary cut, and were unreliable for truth, both in boring and straight work; if a man desired to bore a pulley for a shaft he would have to humor the tool every way in order to get a true bore. There were no chucks either, as we now understand such appliances; the only way to hold a circular job was to use offset straps bolted to the face plate, or in the case of a job which admitted of it, to use an oak block about 3 inches thick, bore it to the right size, and drive the piece to be bored into it. Later came the slotted face plate with four jaws adjusted to size with screws working through them, and later still, about 1852-3, the scroll-chuck which held a round job true without any adjustment; but they were soon put out of commission by the men using levers about four feet long to set them up, alleging that the work slipped in them. It was a long time before the men got over their prejudices against a new thing.

It was the same with twist drills as they are now made. These last were not unknown in the machine shops of half a century ago, for there was a sort of steel auger in use for deep holes; it was not very popular, as it was alleged that it did not clear itself, as may be supposed, for it was simply a steel bar drawn flat and afterward twisted in a vise into helical form, and used, without turning just as it came from the tool-dresser. The first commercial twist drill made and sold in hardware and machine-tool shops was devised by Samuel Morse of

East Bridgewater, Mass., who organized a company to manufacture it for the trade, and carried on the business under the style of the Morse Twist Drill Company which is in operation to this day at New Bedford, Mass. About the same time one Arnold, a machinist in the employ of a firearms company in Newark, N. J., also got up a twist drill of the same general conformation as Morse's, but the enterprise was never pushed and therefore languished.

Tools of Precision.—The last half of the Nineteenth Century was marked by a great awakening, so to call it, in regard to the methods in use for constructing work. Up to 1850 and for some time after that period it was a common practice to go by the drawings furnished, to some extent; but they were not absolutely depended upon, for the simple reason that there was no standard of measurement which could be relied upon for accuracy. The unit of measurement was the inch—but what kind of an inch? According to the boxwood rules which every man carried in his pocket, it was 1/32 over or under a standard inch; hence it became absolutely necessary to leave details larger than the sizes marked on the drawing and fit one piece to another all the way through. This was unsatisfactory in every way, as will be readily understood now, and gave rise to much needless argument and recrimination, as to the ability of the men to work to the drawing. Personal conflicts were not unknown, and so much confusion arose that it was essential to make a change. The steel scales so common now were not then in market, but the Whitworth plug and collar gauges were, and a full set of these were imported and given to the foremen in several shops. The use of them was explained to the men, but it soon transpired that some "lewd fellows of the baser sort" were forcing the caliper gauges over the shafts, and those who were in charge of the collar gauges, which were intended as standards only, had given them to lathe hands to use for sizing shafts, which they proceeded to test for accuracy by trying to drive the collars on the ends of jobs with a hammer. The end of the experiment was that the gauges were practically ruined, and were withdrawn; but about that time the American steel rules, or scales with fine divisions, were marketed and proved entirely satisfactory, and a great impetus was given to accurate machining.

But it was not all plain sailing even then, for the reason that the men would not recognize anything less than 1/32 of an inch as a reasonable limit of inaccuracy; the idea that there was such a division of an inch as the 0.01 part of it seemed hard to realize, and they would sarcastically demand to know if they had to set their calipers to lines they couldn't see without a "spyglass" while the "tenths" and "twentieths" of an inch were declared to be useless because they wouldn't divide by anything; how was a man to use "half of a twentieth" in measuring his job, when there was not any such mark on the rule? They said that if the improvements were insisted upon they would have to get magnifying glasses in their kits, but they soon became familiar with the new order with benefit to all concerned. It was a long time, however before the 0.01 of an inch dimension ceased to trouble some of the finishers; it was to them in the nature of an unreasonable exaction, until one day a traveling salesman showed them that they habitually worked much closer than that, in their daily output, and that they had been scared by a name alone. This man had a plug-collar gauge with him, the plug whereof had been purposely reduced to 0.001 part of one inch smaller than the collar. When he put the plug into the collar it rattled all around it, and daylight was plainly visible through it; every one acknowledged that it was a practical demonstration—that work executed within the 0.001 part of an inch was by no means good work, unless it might be for a sliding fit, and even for that it was too slack.

It must not be inferred from what has been said in the preceding lines that there was no good work done about the middle of the last century in machine shops of the United States, for that would be quite wide of the facts; there is no better done, on the average, in ordinary shops than our predecesssors in the machine business did half a century ago, so far as fitting is concerned; but the methods employed could not be used now for the reason that they would not pay. Time was cheap in those days, good machinists getting only $9.00 a week, and some just out of their time $6.00 a week, doing just as good a job as the regular journeymen, so fitting one piece to another was not so objectionable as it would be now.

In the matter of small tools, nothing gave more trouble and annoyance than the taps and dies, because there was no standard thread recognized for special sizes of bolts; a ⅝ bolt might be either 10 pitch or 9 to the inch, according to the notion of the man who made it, and these sizes would get mixed up in a most vexatious way in the tool room, or the place that was called a tool-room; this was merely a sort of store room where the taps were put in a box, when any one took the trouble to bring them back after use. When a tap was needed the man took the first that came to hand of the required size; this was tried by calipers, for there was no mark on the shank either for pitch or thread, and it sometimes happened that holes were tapped for stud-bolts that could not be threaded with dies in use, because one or the other was found to be a bastard thread, made for some repair job and thrown into the box because it might come handy some other time—when it should have been cast into the scrap heap in the first instance, lest it might make trouble upon regular work. Moreover, many of the taps were cut upon lathes which had lead screws that were worn out—known to be so—but so long as they would cut a thread they were retained in use; a little thing like a quarter or half of a thread out the way was nothing to make a fuss about. As a rule the men took pride in their tasks, and considered a bad job a serious reproach upon their ability and worried over it as if it was a personal matter. There were but few "handy men," so-called—none at all who ever touched a machine tool to operate it, or otherwise than as a laborer to help shift jobs. That would have been resented promptly by the workmen, and though not given to striking they would have left the shop in a body if laborers had been allowed to handle tools; there was, indeed, one man who ran a heavy drill press on routine work which merely required him to keep the drill cutting, but he was 70 years old and a sort of pensioner, ranking as a laborer only.

To modern machinists who may chance to read these brief annals of the old-time machine shop, they may serve to mark the wide difference between that time and the present, when every transaction in a shop is carried on seriatim, according to a preordained plan and system. In spite of the waste and loss everywhere apparent in the old-time shop, the proprietors must have made money, for it existed for nearly seventy years (one of the old "bosses" is still living at ninety years of age) and it is only about two years since the last stone of the old shop was razed to the ground.

In preceding pages I have given the prices for labor nearly sixty years ago, but it must not be inferred from the low rates ruling at that time that the artisans suffered for food or clothing; they had an abundance of both, and good rooms to live in. Before the war for the Union, staples were very cheap—with the exception of flour, which was not; but beef of the finest quality could be had for ten cents a pound, butter for the same, and such food as fish and oysters for a few cents, five or six, per pound or per quart respectively, so that the commissariat was ample. Clothing was also cheap; pantaloons of cotton jear were universally worn in summer; these with a hickory shirt cost $1.50 and would last several months; for holiday wear satinet suits were generally used, and looked well until the cotton back began to show up. Workmen who, in those days, did not attempt to compete with others of larger means.

EDITORIAL COMMENT

FROM the testimony lately taken before the Senate Committee on the Panama Canal—the study of which we most cordially commend to all who are patriotically interested in the great National enterprise on the Isthmus—it appears that unless a radical change is made, we shall not build the "Roosevelt Canal" promised by Mr. Shonts, but the "Cromwell Canal."

Mr. William Nelson Cromwell is a man of phenomenal activity of intellect and executive ability. Whatever the motive, his efforts in the earlier stages of the business were effective in enabling the United States to acquire the rights, franchises, and property necessary for completing the best possible waterway from Atlantic to Pacific. But we seem to have reached the point where the ways fork, and where the interests of Mr. Cromwell and the interests of the country follow different paths.

For our part, we are unfalteringly loyal to the welfare of the United States, and to the best of our ability we shall endeavor to advance it, wherever that course may lead us. At present, it seems to lead directly away from Mr. Cromwell.

* * *

THE recommendation of the lock "type" for the Panama Canal, with a summit level 85 feet above sea, as reported from the Isthmian Canal Commission, appears to be based largely upon the considerations which have made this Magazine a consistent adherent of substantially the same project. We eliminate for the present the factors of time and cost, although they tend to confirm the same conclusion; they have never seemed to us controlling, and as Mr. Wallace points out elsewhere in this issue, they are in any case wholly dependent upon the mode of administration adopted—whether directly by the Government or under honest and able contractors.

The arguments for the summit lake and its attendant features have always appeared to us to be the fuller and more certain solution it affords of the problems of the Chagres and of Culebra, and the much greater ease and security it offers to navigation; and these cover two-thirds of the argument by which the Commission supports its finding.

* * *

THERE is another matter connected with Panama affairs in which we are glad to note that the Administration sees the truth as it had already presented itself to us. The close parallelism of the views may be best indicated by quotation:

From an Editorial in THE ENGINEERING MAGAZINE for February, 1906.	From Secretary Taft's Speech at Detroit, February 10, 1906.
"The greater part of the machinery of the Federal Government is diverted from its proper functions to the carrying on of the Canal investigation, and the whole executive management of the Canal is distracted from constructive effort to the business of being investigated. "We hope that the present inquiry may carry the light into the farthest corners of the Isthmus and of the departments at Washington—that every one who has evidence to give or a grievance to allege may appear and be heard to his heart's content. This is the time for it. But as sincere and consistent advocates of the best canal, for the least cost, and in the shortest time possible, we most earnestly hope that the era of talk may then give place to the era of work."	"A word as to investigations. We have had a good many recently in Washington. The President and all in authority are glad that the Senate Committee is now making a full and complete investigation into every statement of improper conditions of any sort on the Isthmus, regardless by whom made. "But after one thorough investigation has been completed and every truthful man and every liar has been heard, then let the work go on. You can't be answering questions and building a canal at the same time. You can't have the chief engineer and the other constructing officers engaged in that work both in Washington and on the Isthmus. "Therefore I say that all those who wish to be heard ought to be heard now, or ever after hold their peace."

Of course, the Secretary can refer (as we did) only to the scrutiny of what has been done. The investigation, no matter how thorough, cannot forestall the critics of the future. After another year of work under the Government, another party of opponents may—and very probably will—have the desire and the power to investigate all over again. Our editorial just quoted followed with the prediction that "as long as we persist in our present policy these conditions will be prolonged and repeated."

With the canal committed to competent and thoroughly responsible contractors, both the constructors and the Administration might go steadily about their own proper affairs, and the land might have peace, so far at least as the Isthmian Canal is concerned.

* * *

The report of the State River Improvement Commission, lately made public, proposes the control of the floods of the Mohawk and Sacandaga by the construction of storage reservoirs, in connection with the reforestation of the upper basin of the streams—the object of the latter work being, of course, not any problematic influence upon climate, but the certain one upon the rate and time of run-off. With restoration of the large wooded areas, the rainfall would pass much more gradually into the streams; and with the artificial storage provided to receive the excess volume of freshets, not only could flood damage be largely prevented, but the regimen of the stream could be kept much more nearly regular and a serviceable stage maintained through a large part of the year as the stored waters were gradually released.

* * *

This is an interesting adoption of some of the principles enunciated by Professor Haupt in his Franklin Institute address upon the Regulation of the Mississippi, reviewed in this Magazine in December, 1903. In this he pointed out that "remedial measures must evidently be directed towards the prevention of simultaneous floods, and the accumulation of large volumes of water which must be carried in a congested conduit for long distances before it can find relief," and he suggested "impounding reservoirs upon the tributaries, . . . reforestation" and other measures specially adapted to the Mississippi problem.

We are glad, in carrying back still further the review of our own discussion of the same question, to find substantially equivalent measures advocated under the auspices of The Engineering Magazine just eleven years ago. An article on "The Causes of Floods in Western Rivers" in our issue of March, 1895, recommended reforestation, in connection with the installation of a "system of dams by which the greater portion of the freshet in the minor rivers could be retained in great semi-natural reservoirs, and an important double purpose thereby be served: first, the avoidance of the successive discharge of tributary flood waves upon the very crest of flood wave in the main channel . . and second, by the gradual liberation of the stored waters, the maintenance of a navigable stage in the principal stream for a much longer season than the present average." The article in question showed how, under conditions existing in the Central States, much might be done within the limited means even of individual enterprise, and dealt at some length with the incidental gains to be secured. It was an anticipation of the advantages not only of forestalling flood damage, but of realizing true economy in the conservation of our water resources—an anticipation which we are glad to recall under the present approval of the leading authorities on the subject.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE PROTECTION OF THEATRES FROM FIRES.

LESSONS FROM THE FIRE TESTS UPON THE EXPERIMENTAL THEATRE BUILDING AT VIENNA.

Oesterr. Ingenieur und Architekten Verein—Gesundheits-Ingenieur.

WE have recently reviewed in these columns the address of Mr. John R. Freeman upon the methods of minimizing the fire risk in theatre buildings and public auditoriums, and as a satisfactory supplement to this study we now have the account of the tests which have been made in Vienna by the Austrian Society of Engineers and Architects on a model building, designed to reproduce the conditions existing in the structures in which thousands of lives are exposed to danger from fire every evening. The Austrian society has done excellent work in the past in subjecting theoretical deductions to the ordeal of practical test, and has not spared expense, either in money or service in such experimental researches. It is only necessary to mention the exhaustive trials made several years ago by this same organization upon the resistance of large masonry arches to remind the engineering profession of the thorough manner in which such investigations have been conducted.

Nearly two years ago a committee of this society was appointed to make a study of the best methods of preventing disasters in theatres from fire. This committee received ample encouragement from official sources, and the result was a decision to erect a building of sufficient size to represent accurately the conditions existing in modern theatre buildings and to permit fire tests to be made upon a sufficient scale to give unmistakable indications of the right course to be followed hereafter in case of fire by managers and designers of such buildings.

The experimental building was constructed in reinforced concrete upon a scale of one-third that of a theater intended for an audience of 1,500 persons, with stage and auxiliary portions in proportion. Thus, in this building the stage is 7.50 meters wide, 6 meters deep, and 7.70 meters high. The proscenium opening is 3.35 meters wide and 2.60 meters high, behind which is a cross passage one meter wide, permitting the stage to be traversed in front of the settings but behind the curtain. The auditorium is 5.50 meters wide, 7 meters deep and 4.70 meters high, with a single gallery, and outside staircases permitting this gallery to be emptied directly to the exterior. In the back part of the auditorium is a partition made of reinforced concrete, permitting the conditions within to be observed through glass windows.

Several outlets for smoke and gases were provided, the principal one being an opening over the middle of the stage, 2.30 meters long and one meter wide, this being made with two flaps so arranged as to be opened from below by iron connections, the area of the full opening being five per cent. of the stage area, while smoke flues were also arranged at the four corners of the stage. An opening one meter square was also arranged over the auditorium, with double flap opening, all these flaps being arranged to be operated from the outside of the building. An iron curtain was placed in the proscenium opening, arrranged to be guided in iron grooves, this curtain being made of slats 0.6 mm. thick and 12 mm.

deep, and covered with asbestos 4 mm. thick. Sprinklers of the Grinnell pattern were arranged over the stage and in the auditorium, those in front of the stage being placed so as to direct the water upon the curtain. Air for combustion was admitted on both sides of the stage near the bottom, and gas, oil and electric lighting systems installed to permit of the inspection of the action within.

In order to enable the actual conditions on the stage and in the auditorium to be studied, there were fitted recording pressure gauges and pyrometers both before and behind the curtain, together with a gas analysis apparatus for the determination of carbonic acid, oxygen and carbonic oxide, and a recording device was fitted to measure any bulging of the curtain towards the auditorium.

It was desired to reproduce, as nearly as possible, the actual conditions on the stage, and hence this was fitted with old theater decorations and rolls of paper hung upon screens, these being soaked with petroleum in order to insure violent combustion, and so distributed as to correspond to the proportion for a fully set scene on a stage of normal dimensions.

Four sets of trials were made in this experimental building, these being intended to reproduce, as far as possible, conditions which may exist in actual theater structures during performances and when audiences are exposed to danger.

In the first set of experiments all the outlets above the stage were closed, the curtain was up, and the opening in the ceiling of the auditorium was half open, the lights all being turned on. This practically represents the most dangerous state of affairs, and one which is most generally found in existing structures. Within a few seconds after the inflammable material on the stage was ignited the auditorium was filled with smoke and gas to such an extent as to render it almost impossible for life to exist, the draught from the openings in the front part of the building causing the flow to be outward through the proscenium arch. The dropping of the curtain furnished no relief, since this simply compelled the gases and flames to pass through the cracks around and beneath the curtains in jets at a high velocity, this only adding to the danger and intensity of the fire.

This test verified very fully the contention of Mr. Freeman that the absence of openings over the stage is the most prolific cause of loss of life in theatre fires, and the subsequent tests on the Vienna model theater confirm this view.

The second series of tests differed from the first only in having the iron curtain lowered immediately upon the outbreak of the fire, this being effected by providing an automatic release to the curtain, operated by fusible connections. In this case the auditorium filled with smoke more slowly, so that it appears probable that people in the auditorium might have an opportunity to escape.

In the third series of trials the outlets over the stage were left wide open, while that over the auditorium was closed, the iron curtain being kept up. The result was what might be called a "show performance," the entire contents of the stage being consumed without impairing the air in the auditorium, which could be occupied throughout the entire test with safety, the only inconvenience being from radiant heat in the immediate vicinity of the stage. Under such conditions in an actual theatre the entire audience might remain seated and witness the spectacle as if it were a portion of the regular performance.

Finally the ideal conditions were arranged, these including the provision of automatic release both to the openings above the stage and to the lowering apparatus for the iron curtain. Immediately upon the outbreak of the fire, the curtain fell and the fire was wholly confined to the stage, the products of combustion passing out through the opening above the stage, the curtain cutting off radiant heat from the auditorium. An additional element was added to this test by causing the outlets from the auditorium to be suddenly opened, but the only effect of this was to produce a brief discharge of smoke about the curtain, this being almost immediately overcome by the superior upward draught over the stage. When this test was repeated with the automatic sprinklers in operation, the fire on the stage was promptly and automatically extinguished, the steam passing up through the stage opening, and not entering the auditorium at all.

One of the principal subjects of discussion in connection with these experimental tests was that relating to the advisability of attempting to use automatic devices for opening the outlet for smoke and gas above the stage. It is evident that, apart from proper precautions for the prevention of the origin of fire, this matter of providing a free and immediate discharge for the products of combustion is most important, since the slightest delay in this respect results in the delivery of smoke into the auditorium, causing certain panic and confusion, and probable suffocation to those in the upper galleries. Fusible connections require the production of a certain amount of heat before they can become effective, and in the meantime sufficient smoke may reach the auditorium to cause alarm to the audience, with all the possibilities of panic and consequent confusion, and it is not impossible that after a long lapse of time any automatic device may become neglected and inoperative when the alarm does come. If the rule requiring the presence of firemen in the wings during performances is enforced, it is possible that the control of the smoke vents and the safety curtain may well be placed in their hands, and in such case the enforcement of frequent fire drills should insure the free working of the apparatus at all times.

The results of the Vienna experiments confirm in all respects the position taken by the foremost engineers who have given the subject consideration, and there is no reason why, in view of the positive knowledge thus obtained, that entire security should be provided in all places of public entertainment.

THE SMOKE ABATEMENT QUESTION.

THE CONFERENCE UPON THE BEST PRACTICAL METHODS FOR ABATING THE COAL-SMOKE NUISANCE IN LONDON.

Royal Sanitary Institute—Coal-Smoke Abatement Society.

ONE of the important scientific conferences, recently held in London, was that conducted under the joint auspices of the Royal Sanitary Institute and the Coal-Smoke Abatement Society to consider scientific and practical methods for minimising the smoke evil in the metropolis.

Beginning with an address prepared by the president, Sir Oliver Lodge, advocating the general use of gas fuel, the conference treated of the many sides of the problem, including the injurious and unhealthful effects of the present primitive method of consuming fuel, and the best method for improvement.

Among the papers presented at the conference we may note one by Mr. Arthur J. Martin, dealing with the relation of bituminous coal smoke to the production of black fog, and discussing the practicability of substituting gaseous for solid fuel for commercial and household purposes.

There is no doubt that climatic conditions are largely responsible for the prevalence of fog during certain portions of the year in London, but the confusing, expensive, unwholesome black fog is undoubtedly caused by the presence of the finely divided carbon in the atmosphere, aiding in the separation of the moisture in the vesicular form, and mingling with it to foul the air and obscure vision.

"Few people probably realise how large a quantity of coal is consumed in London every year. According to the Coal Tables issued by order of the House of Commons in 1904 the weight of coal consumed in the Metropolitan police district during 1903 was over fifteen million tons. Of the six-and-a-half million people composing the population of greater London four-and-a-half million reside within the city and the county, and it is fair to assume that the population inhabiting the smaller area burns its due proportion of the coal consumed in the larger.

"At this rate 10,400,000 tons per annum are burnt every year on 75,000 acres, an average of 851 pounds per acre per day. On a moderate computation the daily midwinter consumption is probably not less than one-and-a-third times the average, or say 1,135 pounds per acre per day.

"Every pound of coal requires for its complete combustion at least 140 cubic feet of air, or 259,000 cubic feet per acre, equivalent to a uniform layer three-and-two-thirds feet deep. The amount of air consumed by coal fires in one week forms a solid mass twenty-six feet in depth extending over the whole area of the metropolis. The London householder sometimes experiences an unpleasant shock on receipt of his quarterly coal bill. It would be well if he sometimes gave a thought to his air bill.

"The air thus consumed is not abstracted from the atmosphere. It would be better if it were, instead of being, as it is, sent back and supplied for human consumption, with its burden of unconsumed coal and the products of more or less complete combustion. Fortunately the products of combustion, amounting as a minimum to something over 5,000,000 tons per week, do not as a rule fill up the lower strata of the atmosphere, but owing to their warmth and consequent lightness, pass upward, and under favorable circumstances are dissipated by the air currents. During a black fog, however, as both eye and nose can testify, large quantities of these products drop back to the earth."

So far as the method of removing the smoke nuisance goes, Mr. Martin, makes, broadly, two propositions, one being the imposition of a fine or penalty for the production of smoke, or possibly a remission of a portion of taxation to those whose premises emit no smoke, and the other being the provision of a cheap supply of gas fuel to take the place of coal. The second proposition properly precedes the first, since it would be useless to prohibit or penalize the production of smoke without also providing a smokeless fuel at a practicable price.

Ordinary illuminating gas would be too expensive to be generally used as a substitute for coal, but Mr. Martin tabulates other gaseous fuels in comparison with coal and with illuminating gas. This table shows, what is well known, that on a basis of actual calorific value coal has a heating power of six or seven times that of gas of the same monetary value. This advantage on the part of the solid, smoky fuel, however, is neutralised by the fact that a far less proportion of the heat in coal can be utilised than with gas. A gas cooking stove need not be lighted until needed, and the heat is concentrated where it is used to great advantage and the flame is extinguished as soon as it is no longer required.

The whole question may be reduced to a matter of cost, not of total heat units supplied, but of heat units utilised.

Broadly, it has been stated, that if the price of gas can be reduced, in London, to a price of two shillings per thousand cubic feet, its utilisation for cooking, heating, and power will become extremely rapid, while, at a price of 1s., to 1s. 6d. per thousand, it would be fully able to compete with coal. It has been stated before the Royal Commission on coal supplies, that gas can be produced for 6d. per thousand cubic feet at the gas works, the remainder of the coal being due to distribution.

An important element in the reduction in the price of gas lies in the proper utilisation of the by-products. As Mr. Martin observes, there is no more fascinating chapter in the history of applied science than that of the utilisation of the tar which is produced in the manufacture of gas.

"There is no more fascinating chapter in the history of applied science than that of the tar which is produced in the manufacture of gas. Originally a useless encumbrance, which managers were at their wits' end to get rid of, it has yielded in quick succession hundreds, if not thousands, of distinct products, presenting the utmost diversity in their nature and appearance, and many of them of the greatest value in manufactures, the arts, medicine, sanitation, and the household. In the development of the important industries concerned with the extraction of these products lies one of the possibilities of reducing the price of coal gas. Having regard to the great value of coal as a store-house of valuable by-products, Sir William Siemens has characterised the burning of raw coal as 'a barbarous practice.' We may yet live to see the day when the man who uses coal to cook his dinner will be looked upon much in the same light as if he chopped up his drawing-room furniture for the same purpose."

The only way in which an abundant supply of cheap gas for fuel and power can be supplied to London is to generate the gas from the coal at the mouth of the pit, and transmit it to the metropolis by pipe lines. Mr. Martin compares the cost of transmitting power by electricity with that of gas, showing marked advantages in favor of the latter. When the electric energy is generated from the combustion of coal all the losses involved in the operations of conversion and reconversion must be considered, while the practicability of storage of gas gives it an especial advantage in the very feature in which electricity is weak. There is practically no loss in the storage of gas, while the high degree of efficiency attained in the conversion of energy in the gas engine renders this a most desirable type of motor. With gas fuel for heating and cooking, and gas engines for the development of power, the smoke nuisance would disappear, and with it many other inconveniences, such as the handling of coal, removal of ashes, and much laborious and disagreeable work.

The natural place for the generation of the gas is at the collieries, thus dispensing with the most important element in the cost of coal, that of transportation.

"The generating plant at the collieries enjoys a further advantage in the facilities which it possesses for the utilisation of less expensive grades of coal, particularly of the dust and smaller fragments of which no use is at present made. It is estimated that no less then 24,000,000 tons of small coal, or more than twice as much as is consumed in London, are brought to the surface every year and left to perish at the pit's mouth. In addition to this an enormous quantity of small coal is disposed of underground by being thrown into disused workings. Some of the material thus wasted includes a certain proportion of dirt; but by far the greater part of it is good coal, in no way inferior in calorific value to that sent away for sale, and is thrown away merely because in its comminuted condition it is not suitable for many of the uses to which coal of its class is applicable, and will not bear the cost of handling and cartage.

"This waste coal, be it remembered, is got out, and much of it raised to the surface, at hardly less cost than a corresponding weight of good coal, but yielding no return of its own, its cost has to be spread over that of the marketed article, the price of which is inflated accordingly."

In order to show the practicability of the scheme, Mr. Martin gives computations for some concrete examples. Thus to generate, in the Yorkshire coalfields, at a distance of 173 miles, sufficient gas to replace the coal consumed in London in winter the following figures are given. The daily consumption of coal is given as 55,115 tons, corresponding in thermal value to 2,802 million cubic feet of gas of 617 B. T. U. calorific power, or about two million cubic feet per minute. This could be delivered through a main six feet in diameter by a pressure of 480 pounds per square inch. To compress two million cubic feet to 480 pounds per square inch is estimated to require about 575,000 horse-power. If the whole of the gas delivered were used in large gas engines the power developed would be more than nine million horsepower, so that less than six per cent. of the power value of the gas would be required for compression. In practice several pipes would probably be substituted for a single main, and Mr. Martin suggests four lines of pipe, ranging from 36 inches in diameter at the coalfield to 72 inches at the London end, capable of conveying a maximum daily volume, measured at atmospheric pressure, of about 700 million cubic feet, with an initial gauge pressure of 510 pounds per square inch. Various details of the scheme are worked out by Mr. Martin, and there appears to be nothing inherently impracticable in the plan.

So far as costs are concerned, many details must naturally enter into such computations, and many elements of uncertainty, but Mr. Martin estimates that the gas could be delivered at London for 8d. to 10d. per thousand cubic feet, to which would have to be added the cost of storage and distribution. Practically all the mechanical details involved in the compression and delivery of gas at high pressures and long distances have already been worked out in connection with the transmission of natural gas in the United States, the principal difference between the two propositions being in the source of the gas, being manufactured in one case and natural in the other.

When the advantageous conditions under which gas can be used, are realized, and it is seen that this system would entirely relieve the metropolis from the smoke nuisance, its claims to consideration will be appreciated.

THE MACHINE-SHOP PROBLEM.

PRACTICAL DEVELOPMENTS IN SHOP BETTERMENT AND THE INDIVIDUAL EFFORT METHOD OF PROFIT SHARING.

Harrington Emerson—American Engineer and Railroad Journal.

WHILE many men have been theorizing and devising schemes to obtain the maximum of output at a minimum of expense in manufacturing operations, others have been quietly engaged in putting working methods into practice and determining for themselves what can and cannot be done in enabling both employers and employees to make more money out of the business in which they are all engaged. In a paper by Mr. Harrington Emerson, published in the *American Engineer and Railroad Journal,* these questions are discussed in a most practical manner, as some abstracts will show.

"The employee wants as high wages as he can get. The employer wants his output to be as cheap as that of his competitors, for, if it is not, he will soon have to shut down his shop. Both desires are reasonable, and the problem is to reconcile them without injustice to either party. An absolutely clear understanding by both parties of the shop problem of to-day is necessary: the shop problem of to-day, not of years ago, when conditions were very different; not of years hence, when conditions no one can now foresee may prevail.

"The worker cannot be expected to work for one employer for less pay than is paid under similar conditions for the same work by another employer. The wagepayer will not pay higher wages than the current rate, or than business conditions permit. There may be, however, quite a gap between the wages paid by competitors and the higher wages the employer would be willing to pay if it can be proved to him that it is to his advantage to do this. Wages above the current rate cannot therefore be agreed on in advance of performance, but should result from individual effort.

"It is to be made plain to the employer that not by an increase of expense, but by a readjustment of expenditures, he can with advantage to himself give higher pay than the average; and it is to be made plain to the wage-earner that the receipt of higher pay must depend on his own individual character, skill and effort. Up to a certain point, competition and combinations can force wages up, sometimes generally, sometimes only locally and temporarily; but beyond this point there is a possibility of higher than the average pay, to be brought about only by recognition of the fact that the higher rate is to the advantage of both wage-payer and wage-earner."

Formerly it was considered that the direct wages formed the greater element in the cost of a manufactured article, but with improvements in methods, machinery, and appliances the labor cost has dropped, and the cost of materials takes the first place, followed by the general expense and the direct labor. The distribution of these must be determined both by an investigation of the plant and of the accounts. Mr. Emerson is considering the shops of a railroad system, including the building and repairs of locomotives, and he shows that a condensed statement in such a case reveals the fact that materials are more important than general expense, and that these in turn are more important than labor costs, and he examines all three in detail.

So far as materials are concerned, it must be emphasized that *all* the material, of every kind, must be included. Too often it is only the material which appears in the finished machine which is taken in finding the cost, but all the material which goes into the shop has to be paid for, and it must all be accounted for. A spoiled casting belongs to the machine into which it did not go, the fitting ordered and not used must be charged likewise, and all the waste incurred by each job belongs to it. In like manner each machine must be charged with the direct labor of which it is the cause, whether it gets into the completed job or not. There is a large shrinkage in the direct labor paid for and that which goes into the finished product. If a casting is partly machined and has to be thrown away, the labor put on it is lost; if a man waits an hour for work, or for crane service, or studies an hour over a poor blue print, the money paid for his time is lost. If a man's machine breaks down, if his belts slip, if his tools are of poor quality, if the cast iron is hard, if his machine chatters, if in consequence he takes twice as long a time as he would like to give the work, half of his time is lost, but it has to be charged for in the cost of the engine.

General expenses all have to be charged to the product, as is well understood, although the methods of apportioning them differ in different systems. There is no difference in opinion, however, about the desirability of reducing this element of cost.

"This might be reduced somewhat if fewer foremen, watchmen, timekeepers and bookkeepers, tool dressers, repair men, were required; and fewer of these men are required for good workmen than for poor. The best way, however, to reduce the percentage of general expenses is to increase output, as the larger part of general expense remains the same whether 10 or 1,000 engines are made. To increase output the employer puts his machines in good repair, lines up his shafting, renews and maintains his belting, puts in emery wheels, stops up the air and steam leaks, increases his air pressure, puts up better drawings, supplies better small tools, dresses and tempers and grinds them better, secures jigs and special devices, and makes it possible for the worker with less exertion than formerly to turn out considerably more work."

The best method of reducing the labor cost is by increasing the pay for direct labor in such a manner as to increase the output, and thus diminish the proportion of general expense. Thus, if there is an increase of 20 per cent. in wages and an increase of 20 per cent. in output, while materials increase only 10 per cent., and general expense not at all, there appears a reduction in cost of the product of 9 per cent., gained solely by the cutting out of useless wastes, and hence benefiting both employer and employee.

A practical method for applying this idea in the railroad shop required to be devised, and Mr. Emerson shows how this has been done in cases under his observation.

"The method adopted has long been in use in paying engineers and firemen on the railroads of the United States. It was thought that no better method could be devised than one adapted from such a model, and satisfactory to men of such skill and standing among the employed. In operating trains the employer makes the roadway, maintains the track, furnishes the engines and trains, installs the system of signals, makes out a time schedule, appoints a dispatcher, and then gives the train to its crew. The ability to make the schedule depends on the conditions furnished by the employer and on the diligence and skill of the crew. The latter are expected to make the schedule, but if they fail through any fault not their own, they receive time pay although the train stands still; and if for any reason they make extra effort, run more miles than the schedule calls for, they are paid for the extra miles.

"As far as possible this system has been adapted to the machine shop. A schedule is made out, a reasonable standard-time is set, such as any skilled man ought regularly to make, a schedule on which any good foreman ought to insist. For doing work in standard time the wage-earner receives 20 per cent. increase of pay above the hourly rate. He is paid this extra 20 per cent., not to work beyond reason, but to use his brains as well as his hands, to be his own foreman, to help keep conditions as they should be, to assist the employer in maintaining high efficiency in tools and machines.

"If for any cause whatever he does not maintain schedule standard time, he is still paid an extra amount until time-and-a-half has been used on the job. If he falls below time-and-a-half, he still receives his regular hourly rate, which is never interfered with. If, however, he does better than standard time, then he is given all the gain due to his own time. If standard time is 1 hour, if the rate is $0.25 an hour, if the extra pay is $0.05, making a total of $0.30, then, if the work is done in one half-hour the wage-earner is paid $0.30 for one half-hour's work, or at the rate of $0.60 an hour. If, however, he takes 2 hours on the job, he receives $0.50, or at the regular rate of $0.25 an hour. This shows why it is possible by unusual and extraordinary effort to earn a large extra amount.

"This method of profit-sharing, of rewarding individual effort of both employer and employee, is utterly different from piecework, with which those who have not investigated it have confounded it. In day work the employee is paid for his time, and he gets the same wages whether he works extraordinarily well, badly, or not at all. In piecework the employee is not paid for time, but for output. He takes all the risks of conditions over most of which he has no control, and if he seems to make too high wages the rate is often cut. Under the individual effort system the wage-earner is guaranteed his regular hourly rate irrespective of output. It is the foreman's duty as well as his own to avoid unnecessary delays. His hours are definite both as to beginning and end; his nights and Sundays are his own, and overtime being recognized as an evil to both employer and worker, it is eliminated as far as possible, the employer being forced to pay time-and-a-half for every extra hour. Wage-earners have contended for shorter hours, yet with opportunity to earn regular rates of wages. Under the individual effort system a man can work eight hours, yet earn as much as he formerly earned in ten hours."

This method is free from one of the great objections to piecerate systems, in that the rate cannot be cut, because there is no rate by the piece, and if any attempt is made to cut the standard time the workman can fall back on the day rate and make such an attempt most unprofitable for the employer. All the trouble and expense to improve conditions will be in vain unless the employer can induce the wage-earner to co-operate; and the easiest method to secure co-operation is to offer an opportunity to make an increase in pay.

"Does the individual effort system result in discharging old men because they cannot attain the times of younger and stronger men? This question provokes a smile. The 20 per cent. extra pay is given, not for hard work, but for head work. The younger men may not know it, but the older men are wiser, and if they do not have the bull-strength method of accomplishing, they supplement energy with intelligence in running a machine or planning an operation. They make few false moves, they take the stitch in time, they know that a carefully tempered and ground tool set at exactly the right angle will cut easier, faster and longer than a tool selected and set without the knowledge that long experience alone gives. Young men by driving their machines at an extraordinary rate have earned extraordinary pay, but it is the older men who in the long run will draw the most extra pay, who turn out the most reliable and satisfactory results. Some of the most productive workers are men between 50 and 60: productive not because they use their muscles, but because they use their heads."

AUTOGENOUS WELDING.

THE USE OF THE OXY-HYDROGEN BLOWPIPE FOR THE COMMERCIAL PRODUCTION OF WELDED SEAMS IN METALLIC STRUCTURES.

E. Wiss—Verein Deutscher Ingenieure.

THE art of welding is doubtless as old as the use of iron in the arts, and its development, from the manipulation of pieces within the limits of human strength at the blacksmith's forge, to the massive productions of the steam hammer and the hydraulic forging press its operations are well known. Within the past few years, however, there has been developed a series of methods of autogenous welding, or union of pieces by the fusion of a portion of their own substance, using gas fuel, and gradually progressing from the direct use of gas burners to the employment of the oxy-hydrogen blowpipe and more recently of the oxy-acetylene blowpipe. In a paper recently presented by Herr E. Wiss before the *Verein Deutscher Ingenieure,* and published in the *Zeitschrift* of the society, the present state of the art of autogenous welding is discussed, with interesting examples of the manner in which what was formerly a curious laboratory experiment has become an everyday manufacturing operation.

The use of water gas for welding has

already been extensively employed, the gas being taken from a holder and compressed mechanically for delivery to the burner, the air supply being controlled so as to be somewhat less than the quantity required for theoretically complete combustion in order to avoid oxidation of the metal at the welded seam. Joints thus made have shown satisfactory results, the tested strength of the seam reaching ninety-nine per cent. of the solid material, but the size and cost of the plant required limits the application of the method to establishments in which the conditions of work warrant the outlay. Apart from the character of the apparatus, it has been found by experience that the water-gas system is impracticable for sheet metal below about eight millimeters in thickness, although it has been employed to advantage for sheet iron or steel from eight millimeters up to fifty millimeters thick.

After briefly reviewing the processes of electric welding, including both the arc and the resistance methods, Herr Wiss proceeds to discuss the application of the blowpipe with mixed gases. Considering first the oxy-hydrogen blowpipe, Herr Wiss examines and compares the theoretical and practical conditions. The combustion of two parts of hydrogen with one part of oxygen should generate theoretically a temperature of 6,700° C., but by the dissociation of the vapor of water this temperature falls to 2,400° C. By an examination of the temperature of a mass of magnesite exposed to the action of an oxy-hydrogen blowpipe, using the Wanner optical pyrometer, Heerr Wiss finds that a temperature of 2,100 is actually attained. The difference is accounted for partly by the inability of the pyrometer to perceive the maximum temperature and partly to losses by radiation.

The ability to produce high temperatures by use of the oxy-hydrogen blowpipe has been known for a long time, and the principal impediment to the use of the apparatus in the arts has been the high cost of the process. It is only with the introduction of modern processes for the economical manufacture of the gases that the method has come into use in the industrial arts, but there is every reason to believe that present facilities will lead to its extended use.

Two methods are at present in use for the production of oxygen for commercial and industrial purposes. One of these depends upon the electrolytic decomposition of water for the production of both the oxygen and the hydrogen. The other remains as about the only really commercially valuable application of the production of liquid air, and depends upon the fractional distillation of this interesting liquid for the separation of the oxygen from the nitrogen in form for practical use.

In practical work it is found that more than the theoretical proportion is needed, and hence the ordinary decomposition of water, while furnishing the theoretically correct proportions of oxygen and hydrogen, is not altogether sufficient. At the same time it is found that, in the ordinary operations of chemical industry large volumes of hydrogen are released, and this may be isolated, as a by-product, and placed at the disposal of the engineer.

The production of oxygen by the fractional distillation of liquid air has already been discussed in these columns, and it is now conducted on a commercial scale in various countries. In Germany the undertakers of the Linde process are prepared to furnish oxygen of ninety-five per cent. purity at a price of 4.5 pfennigs per cubic meter, at the rate of 100 cubic meters per hour and allowing twelve pfennigs for the cost of compression it seems that the present selling price of 2.5 marks per cubic meter should be reduced very materially before long, since the manufacturing cost is about twenty to twenty-five pfennigs, including everything.

In practice the oxygen and hydrogen are used from receivers in which the gases are compressed to 125 to 150 atmospheres. In this connection Herr Wiss calls attention to the objectionable practice of lubricating the oxygen compressors with oil or glycerine, this permitting the presence of hydrocarbon vapors, which, at the temperatures of compression, may lead to ignition and explosion. Compressors used for oxygen should be lubricated only with water, which answers every purpose. There is no objection to the lubrication of hydrogen compressors with hydrocarbons, providing the lubricant is prevented from passing into the flasks in which the compressed gas is stored.

Formerly the gases were consumed in the

type of burner devised by Daniel, in which the gases were not mixed until the moment of combustion, but it has been found that a higher temperature is obtained if opportunity is given for a more intimate mixture than is thus possible. Present practice provides a mixing nozzle with a chamber beyond, from which the gases are delivered to the burner point, this latter having various sized tips provided, according to the nature of the work.

The rate of combustion is dependent upon the proportion of oxygen present. When the theoretical mixture of two parts of hydrogen to one of oxygen is reached there is apt to be a succession of little explosions and in practice it is found that the best proportion is four to five parts of hydrogen to one of oxygen, this also preventing the formation of a flame which will oxidize the metallic surfaces under operation.

Herr Wiss illustrates and describes the methods of using the blowpipe for the welding of structures of sheet metal of various irregular forms, and shows the ease with which the apparatus can be used, even upon material down to three millimeters in thickness. For complicated pieces especially, the method is more economical than other methods of working, besides which the finished piece has the advantage of being entirely seamless and with the strength of the metal in all parts practically unimpaired.

The use of acetylene in place of hydrogen is discussed in the paper, with especial reference to the application of the Fouché process of storing acetylene gas under pressure in an absorbent material charged with acetone. Since the heating value of acetylene is materially higher than that of hydrogen, a higher temperature may be produced by this apparatus than with the oxy-hydrogen blowpipe. It has been computed that the temperature in the oxy-acetylene burner approximates 3,600° C., but Herr Wiss states that an examination with the Wanner pyrometer shows the highest temperature attained in practice to be about 2,340° C., as compared with 2,100° C. for the oxy-hydrogen blowpipe. Since 1,900° is ample for the welding of wrought iron plate, the higher temperature appears unnecessary, and possibly injurious, so that there is no necessity for using acetylene where hydrogen is found amply effective.

The paper of Herr Wiss contains much useful information about a process which has already found many valuable applications, and which, with impending reductions in the price of oxygen, bids fair to become a standard appliance in the operative machine shop.

POWER PLANT ECONOMICS.

A COMPARATIVE STUDY OF THE COMMERCIAL AVAILABILITY OF VARIOUS TYPES OF PRIME MOVERS FOR POWER HOUSE SERVICE.

Henry G. Stott—American Institute of Electrical Engineers.

IT has generally been supposed that the introduction of the central power-generating station meant a material gain in economy over the use of isolated plants and separate equipments, and it certainly does seem as if power should cost less when generated wholesale than at retail. There is a growing belief among practical men, however, that the great central station is not so remarkably efficient after all, and that there are many small private installations which, if the facts were only known, were beating their more pretentious neighbors very materially, so far as the actual cost of the power in money is concerned. The central power plant engineers themselves appear to have been roused from a somewhat complacent frame of mind which existed not so long ago, and are really endeavoring to see what can be done to avail themselves of the latest systems for securing maximum commercial efficiency in the conversion of thermal to electrical energy. In a paper recently presented before the American Institute of Electrical Engineers by Mr. Henry G. Stott, this question of power plan economics is discussed very effectively, and a decided disposition to climb out of the rut is shown, which is indeed encouraging.

Mr. Stott calls attention to the fact that about three years ago the steam power plant of the electric generating station appeared to have settled down to a standard type, the various installations differing from one another principally in unimportant details.

"After a long period of development a new factor in power-plant design; namely, the steam turbine, was placed on the market in commercial sizes. It is safe to say that during the last three years no other piece of apparatus has had so stimulating an effect upon the power plant. Its effect upon the entire plant has been most beneficial, for it has revived the apparently moribund superheater. This has now been so developed that superheat of 200° or 300° fahr. can be safely and economically obtained. With the development of the superheater further study of the problem of combustion has improved the efficiency of the furnace; and this most important subject is apparently susceptible of still further development.

"One important result of the steam-turbine development has been the development of condensing apparatus to such a point of efficiency that a vacuum within one inch of the simultaneous barometer reading can now be maintained without difficulty.

"Another change in the power plant has been the reversion to high-speed generators, resulting in decreased cost of the generator and its foundations, as well as saving in floor space.

"Last but not least the steam turbine has put the reciprocating engine and the gas engine on the defensive and has actually been unkind enough to throw out hints in regard to the application of Dr. Osler's proposed methods to the treatment of older apparatus.

"The reciprocating engine and internal-combustion engine have not been slow in accepting this challenge; they have responded by showing so improved an economy (especially in the gas engine) that the situation has become most interesting to the power-plant designer. It is safe to say that the developments of the next ten years will show very marked improvement in power plant efficiency."

In comparing various systems of power generation, Mr. Stott first analyzes the performance of a modern standard plant of high efficiency, and typical of the present state of the art, so far as the use of the reciprocating engine is concerned. For the detailed analysis of the losses in such a plant reference must be made to the tables in the original paper, but the principal items are: nearly 3 per cent. to the stack, 8 per cent. in boiler radiation and leakage, and 60 per cent. rejected to the condenser.

Of these items the loss to the stack is largely due to excess of air in firing, and by the use of scientific methods in the fire-room, aided by modern appliances for recording the production of carbonic acid in the gases, this loss should be reduced to 12 or possibly 10 per cent. Boiler radiation losses may be reduced by the use of larger units, thus diminishing the proportion of radiating surface, together with the employment of an air-tight casing, as introduced in London by Mr. Patchell.

So far as the proportion of the heat rejected to the condenser is concerned, Mr. Stott goes into the thermodynamics of the question far enough to show that the maximum possible efficiency depends upon the temperature range through which the engine is worked, this enabling the available margin from which further economies may be made to be determined. In this way he shows that with the present type of power plant, using reciprocity engines the stack losses may be reduced about 12 per cent., the losses by boiler radiation and leakage by about 5 per cent., and the reduction in engine losses, by using superheating, by 6 per cent., these bringing up the total thermal efficiency from 10.3 per cent. to 14.44 per cent.

Turning to possible modifications in the type of prime mover, Mr. Stott first calls attention to the combination of high-pressure reciprocating engine with low-pressure steam turbine on the exhaust, this being the arrangement originally devised and put into execution by Rateau. The reciprocating engine is most efficient in its high pressure cylinder, while the expansion of the steam is most efficient in the low-pressure portion of the steam turbine, hence the combination permits the use of the more efficient portion of each machine.

Another type of motor to be considered is the gas engine, and here Mr. Stott has some excellent and original suggestions.

The high thermal efficiency of the gas engine is fully established, and the principal delay in its introduction for the power house has been due, not to the engine, but to the gas producer. Still, there are certain difficulties in connection with the engine itself.

and this point is the one to which Mr. Stott has given attention.

"The great objection to the use of the gas engine for electrical purposes has been: first, its lack of uniform angular velocity; secondly, its uncertainty in action and high cost of maintenance; and thirdly, its inability to carry heavy overloads. Recent developments have removed the first and second objections; and a period of vigorous development has resulted in placing the gas engine in the front rank of claimants for attention as a prime mover.

"The total investment for a gas-producer plant, all auxiliaries, gas engines, and electric generators, has been reduced by the elimination of the gas-holding tank to a point where it is now practically on a par with a first-class steam plant using high-grade reciprocating engines.

"Where natural gas or blast-furnace gas can be obtained the gas engine has outdistanced all competitors; and now that some of our large manufacturers have taken up in earnest the problem of designing producer-gas plants, it is safe to say that rapid developments will result.

"The records of operation of several important installations of gas engines in power plants abroad and in this country seem to indicate that only one important objection can be raised to this prime mover, and that is that its range of economical load is practically limited to between 50 per cent. load and full load. This lack of overload capacity is probably a fatal defect for the ordinary power plant, more especially for the average railroad plant operating under a violently fluctuating load, unless protected by a storage-battery of comparatively large capacity.

"Over a year ago, while watching the effect of putting a large steam turbine having a sensitive governor in multiple with reciprocating engine-driven units having sluggish governors, it occurred to the author that here was the solution of the gas-engine problem; for the turbine immediately proceeded to act like an ideal storage-battery; that is, a storage-battery whose potential will not fall at the moment of taking up load, for all the load fluctuations of the plant were taken up by the steam turbine, and the reciprocating units went on carrying almost constant load, whilst the turbine load fluctuated between 0 and 8,000 kw. in periods of less than 10 seconds.

"The combination of gas engines and steam turbines in a single plant offers possibilities of improved efficiency whilst at the same time removing the only valid objection to the gas engine.

"A steam turbine unit can easily be designed to take care of 100 per cent. overload for a few seconds; and as the load fluctuations in any plant will probably not average more than 25 per cent., with a maximum of 50 per cent. for a few seconds, it would seem that if a plant were designed to operate nominally with 50 per cent of its capacity in gas engines and 50 per cent. in steam turbines, any fluctuations of load likely to arise in practice could be taken care of."

In addition to the question of care of overload, made possible by the combination of the gas engine and the steam turbine, this arrangement renders it possible to utilize some of the heat rejected by the gas engine in connection with the steam plant. Thus the jacket water of the gas engine, discharged at a temperature above 100° is available as feed water, while the heat in the exhaust gases can be utilized either in economizers or directly in boilers or superheaters. Summing up, Mr. Stott makes the following points as worthy of consideration in the design of power plants:

"The present type of steam-power plant can be improved in efficiency about 25 per cent. by the use of more scientific methods in the boiler room, by the use of superheat, and by running the present types of reciprocating engines high pressure, and adding a steam turbine in the exhaust between the engine and the condenser. At the same time the output of the plant can be increased to double its present capacity at a comparatively small cost for turbines and boilers.

"The steam-turbine plant has an inherent economy 20 per cent. better than the best type of reciprocating-engine plant, not so much due to its higher thermal efficiency as to a variety of other causes.

"An internal-combustion engine plant in combination with a steam-turbine plant offers the most attractive proposition for efficiency and reliability to-day, with the possibility of producing the kilowatt-hour for less than one half its present cost."

METHODS OF COST ESTIMATION.

THE PRELIMINARY DETERMINATION OF COST AND SELLING PRICE OF ENGINEERING AND MANUFACTURED PRODUCTS.

A. W. Farnsworth—Coventry Engineering Society.

MUCH has been written and discussed about methods of cost-keeping, both as to the determination of time and material and to the general expense distribution in manufacturing businesses, but nearly everything which has been published in this line has been devoted to the finding of the costs of completed articles. The converse problem, that of estimating the probable cost of an article yet to be made, is a question which has to be answered daily in many large establishments, but there is comparatively little public information to be had about it, and from the wide discrepancies which appear in simultaneous bids upon identical undertakings it is evident that the practice of leading firms is not harmonized. An interesting paper upon the subject of the estimation of costs was recently presented before the Coventry Engineering Society by Mr. A. W. Farnsworth, and some abstract and review of his treatment of an important question is here given.

"The increased severity of competition in the engineering trades has automatically compelled the attention of manufacturers to be directed most seriously to their estimating departments, and of late much has been printed and said on the matter by both interested and outside parties. For every job in the market there are now several—in some cases dozens—of competitors, any one of whom is able successfully to undertake it, and the natural consequence has followed; prices have been gradually cut and cut until in many cases profits have completely vanished. But when a man or a company owns a works in which a great deal of capital has been placed, it is necessary that a turnover be secured, otherwise the dead charges alone will soon bring banksuptcy, and modern specialisation has been directed towards, on the one hand, reducing costs in the works, and towards, on the other hand, gaining a finer and truer appreciation of those costs in the office. Yet, notwithstanding all that is already known of these things by the heads of our establishments, all that has been written, and all that has been published, the quoted prices for engineering work to-day based on the same drawings, specification and information—stand as evidence that we have as yet barely touched the fringe of the subject, that we are still very much in the 'guessing' stage, and that scientific methods of estimating remain in embryo."

Mr. Farnsworth gives some examples to show the crudeness of the methods adopted in practice, citing nine sets of estimates upon three different jobs. Upon the first job there was a difference of nearly 115 per cent. between the lowest and the highest bidder; on the second more than sixty per cent., and on the third about twenty per cent., the first example being the smaller value and the third on a piece of work more than ten times as large. There is no indication whatever that all the estimators upon these jobs were not perfectly honest, and doubtless the actual cost of the work would have varied somewhat in the different shops, but such discrepancies as appeared can only have been caused by defects in the methods by which they were determined.

"It is curious to the onlooker to note the different methods of the average estimator. No two men will perhaps approach any one job in the same way. Some men lump, others minutely dissect, others again try the halfway house; yet all desire the same end—accuracy. Often past costs are turned up and efforts made to apply the figures found, but only those who try know how often this ends in wholesale rejection of the old figures and the substitution of empirical ones. Of course, when an article is standardized—such as a 12-in lathe or similar tool—and prices are fixed, these remarks have not the same force. In such cases the old figures are used over and over again, and some semblance to accuracy is found; but estimating as a science is misapplied to multiples of the same thing; its true scope is only found when every new job differs from every old one, or when a totally new pattern of an old tool is being introduced. Generally speaking, the old-style estimator looks at a drawing and endeavors to frame in his mind a picture of what he sees and to allocate the whole into a particular division or class; thus, if it be a new pattern of twist drill, he will mentally compare it with other patterns and put it in the same class as the pattern it most nearly resembles; when he has succeeded in doing this he is persuaded in his own mind that he knows exactly what it will cost, and down goes the price in a lump sum. Sometimes he is wrong, sometimes right—anyhow, he has but attempted a shrewd guess, and this is not science. The new-style estimator has a very different way. He produces records of the costs of past work, figures worked out to two or three decimal places, searches his file for verification of turning, cutting, millling, and other prices, turns up the actual cards of the several jobs and extracts lots of information—what for? To hatch new figures which will be applicable as nearly as he can tell to the new work. The different decimals are added together, and a result presumably accurate to the hundredth part of a penny is produced; the real net result being, however, only another form of guesswork. The new style is science, yes, but misapplied.

"There can be small doubt that ideal estimating consists in minute dissection and gradual building up of the total price from an aggregate of properly considered minor operations. There is neither no question that accurate costs of previous work are essentials to any success. We can subscribe to this without further argument. Estimates, whether of machine tools or bridges, should be built up in very much the same way as a builder arrrives at his lump sum price—from a bill of quantities with each item carrying its allotted and proved sum. It is, however, to be hoped that while the system itself is followed the results will be more authentic than the average builder's tender. The connection between costing and estimating is most intimate—in fact, seventy-five per cent. of the necessity for incurring expense in costing is due to the exigencies of the estimator, and with a view to future work, the other twenty-five per cent. being taken up with the desire of seeing that the work does not exceed its estimate, and of checking its progress and arranging that by hook or by crook it shall come within the estimated figures. The estimator is nothing without his costs, and it follows that the prime necessity of his being is that his costs shall be reliable. How to make them so is what everyone interested in the question is trying to solve to-day. Many men pin their faith on some particular system of keeping accounts, some novel ruling of ledgers and cost books, or a certain size and configuration of a card; now, while one certain method of keeping figures in juxtaposition may be admittedly better than some other method, it is utterly vain to expect that accuracy and reliability will ensue because of the method. Whole storerooms full of figured papers may well result from the system, and any little part of the whole may be instantly accessible; but unless the little part when found is actually reliable, it is of small use except to look at; it is a monument to great, painstaking, and intelligent arrangement of detail, but it is useless as a fact.

"Hard facts are what the estimator wants—more or less accurate approximations are what he usually gets."

One important element in the accurate determination of values for estimates is the opportunity which is given to the estimator to become familiar with the actual cost methods in the shop. In many large establishments the estimating and the costing departments are carefully separated, and the men in one department are not permitted to know anything about what is being done in the other. This is absurd and cannot but impair the usefulness of the estimates, since accurate estimating depends upon good costing, and the two departments should be operated in harmony and coöperation. Mr. Farnsworth himself believes that the estimator and prime coster should be combined in the same individual, and that he should not be compelled to look at totals worked up in another department by any process imaginable for his information as to how things have gone. He should see the whole makeup of these totals, and by living in them and with them he will imbue the spirit of them and be able to see in what way and for what reasons items and processes may be altered or modified. Such a man should possess first-class engineering knowledge, keen business perceptions, and abundance of tact. The material from which he may be developed may be found in many men now occupying subordinate positions, and when such a post is created there should be no lack of men to fill it.

The only correct way in which a proposed piece of work can be estimated is by a minute dissection of the whole into its parts. The cost of patterns must be determined by a comparison of estimates by the patternmaker with actual costs of similar work already made, checked by the personal knowledge of the estimator. An important element in this and all other parts of the question is the determination of the time required, not only because of the point of time of delivery, but because expense charges are largely dependent upon time. Foundry costs must be based in like manner upon actual data from similar work, the estimator making careful allowances for dead charges, for the influence of other work in hand, and for the quantity and quality of material required. It is grossly unfair to take either the wage costs of the weight turned out and lump on a never-varying percentage obtained from the average of a year's working. Each particular job should stand its own expenses as nearly as scientific methods can make it, and here accurately kept costs will be of incalculable advantage.

"By the time the foundry has turned out the castings the machine shop has to take them, and here again very careful work is necesssary. The foreman should be taken into confidence and help in the framing of the machining costs. Every piece must be considered and labor expense detailed; the machines available and the other work in hand will want taking into account, as also the probable demand on the motive power, the time the job will be about, the handling it will take, and the attention to be given by the cranes, the space it will take up, and the laborers' time it will absorb. Every single factor entering into its composition as a job will require thinking about. Similarly, in the erecting shop, and again in the testing and proving yard. Nothing can be neglected; everything must be considered, and have its place. Is this, then, work for clerks untrained in the love of the shops? Can it be safely left to the perspicuities of the different foremen only? It demands and should have a master mind."

THE AUTOMOBILE OMNIBUS IN PARIS.

PLANS OF THE GENERAL OMNIBUS COMPANY OF PARIS FOR THE INTRODUCTION OF AUTOMOBILE VEHICLES FOR PUBLIC SERVICE.

Lieut.-Col. G. Espitallier—Le Génie Civil.

ALTHOUGH the construction of the underground railway in Paris, and its continual extension, in accordance with the general plan, to many parts of the city has caused an active competition with the omnibus system, no serious attempt has been made until very recently to meet this competition. In some portions of Paris omnibus lines from which a large portion of the traffic has been diverted have been discontinued, but on the whole an extreme conservatism has been shown in dealing with the question of improved transport on the surface. Meantime other cities have shown activity in the improvement of methods of surface transport, and in London the automobile omnibus has made greater advance in public favor than in France, notwithstanding the success which has attended the development of other types of automobiles across the channel.

In a recent issue of *Le Génie Civil* an account is given by Col. Espitallier of the difficulties which have been in the way of the automobile omnibus in Paris, and the plans which have been made to overcome the obstacles which have deferred the advent of such vehicles on the streets. An important element in the supercession of the horse by the machine is that of operative cost, and in this respect London, under different fiscal conditions, has a great advantage over Paris. Thus the essence which constitutes the most suitable fuel for such vehicles costs only seventeen francs per hectolitre in London, while in France the price is increased by ten francs for duty, and in Paris by twenty francs more for the *douane,* or municipal tax, the selling price being forty-seven francs fifty centimes per hectolitre. For the 300 omnibuses operated by the Paris company this means a cost of 2,500,000 francs per annum greater in Paris than in London. At the same time the municipal authorities of Paris are more interested in the development of new systems of transport, such as the electric service of the Metropolitaine, than in any reduction of the *douane.* There is, therefore, in Paris a necessity for the demonstration of the actual operative efficiency and economy of the automobile omnibus before a company such as that controlling the Paris omnibus system can feel justified in making the change from animal or mechanical power, with all the investment outlay which it involves.

During the recent road trials between Paris and Havre, already reviewed at length in these columns in November of last year, some valuable data as to the performance of automobile omnibuses were obtained, but in addition to these results the *Compagnie Générale des Omnibus* decided to institute further trials, and hence invited a number of eminent builders to submit such vehicles to a series of identical trials. As a consequence of these investigations a regular service was started between the Bourse and the Pont d'Alma and maintained during the month of December, at the time of the Automobile Salon, with much success. The time for the traverse of the course was nineteen minutes, which, with a stop of five minutes at each terminal, makes forty-eight minutes for the round trip, and this schedule was maintained with perfect regularity. Col. Espitallier gives descriptions of the various vehicles which were submitted for trial, with data as to their performance, and the information thus gained should prove of general engineering value and interest.

There is a general similarity in appearance in the different machines, this being due to the fact that each manufacturer furnished his own chassis, while the bodies of all the vehicles were supplied by the omnibus company from standard patterns. As a matter of fact, it does not appear that any of the machines were especially designed for the special service in the streets of Paris, the running gear in each case being that already devised for trucks and lurries for the transport of merchandise, the omnibus bodies being mounted upon the chassis to convert these vehicles into passenger omnibuses. Nearly all of the machines submitted for trial were operated by internal-combustion motors connected to the driving axles by gearing, but among them were some using electrical transmission, the motor driving a dynamo feeding electric motors on the axles, this system giving great flexibility of control, necessary in the crowded streets of a great city, while one vehicle used the Serpollet system, involving the steam boiler of the instantaneous flash type and the steam motors associated with this design.

Reference must be made to the original paper for illustrations and descriptions of the various machines subjected to test, but some of the conclusions may be given here.

In general, it appears that motors running at speeds of not more than 300 to 900 revolutions per minute are better adapted for omnibus service than those running at higher rotative speeds. In view of the occasional steep grades to be overcome, it has been thought advisable to provide from thirty to thirty-four horse power, the omnibuses themselves weighing from four to five tons, in addition to the weight of thirty passengers and the conductor. Experience in the Paris-Havre trials, as well as the results obtained in service in the streets of Paris, show that the cost of fuel is about twenty centimes per kilomtre.

One of the important elements in the operation of automobile omnibuses is the question of tires. The various machines submitted in the trials were equipped with tires of various types, among which may be noted the solid tires of the Ducasble type and the Français tire, composed of separate blocks of rubber. It has been estimated that the cost for the maintenance of the tires will reach 10,000 to 12,000 francs per year for a vehicle in regular service, an important element in the matter of operating costs, and one which may well occupy the interested attention of inventors and investigators.

The question of substituting mechanical traction for animal power in the streets of great cities is one which may well occupy the attention and efforts of engineers and capitalists. Rapid transit is essential when the dimensions of large cities are taken into account, and while it is probable that underground railways at high speed will carry the bulk of the long-distance traffic, there will always be a demand for prompt and efficient transport for moderate distances on the surface. The time is doubtless approaching when the presence of the horse must be prohibited as an unhealthful nuisance in the modern hygienic city, and this means that the mechanically propelled vehicle must be prepared to meet the emergency.

FIRECLAYS AND MOULDING SANDS.

THE NATURE AND PROPERTIES OF REFRACTORY MATERIALS IN PRACTICAL USE IN FOUNDRY OPERATIONS.

Percy Longmuir—British Foundrymens' Association.

IN many ways there is encouraging evidence that the foundry is rapidly rising to a position fully equal, from a scientific point of view, to that held by other departments of industrial technology. The rule of thumb, and the predominance of empirical methods are giving way to the processes of the laboratory, or rather to practical methods derived from correct scientific principles, and the results are already most encouraging.

In a paper recently presented by Mr. Percy Longmuir before the British Foundrymens' Association the requirements of the foundry as regards refractory materials, both for furnace linings and for moulds, are discussed, and this very practical subject is treated in a thoroughly scientific way.

Since the function of refractory materials is to resist a high temperature it is essential to have some definite knowledge of the actual temperatures occuring in different departments of foundry work. In furnaces these temperatures range from about 1,200° C., in a crucible for brass, up to about 1,800° C. in the open hearth steel furnace. In the ordinary cupola it may be taken as from 1,500° C. to 1,600° C. The temperatures in the moulds naturally vary, according to local conditions, but run somewhat lower than furnace temperatures. For aluminum the mould will attain a heat of about 690° C., while for gun metal it will run over 1,000°. For white cast iron the temperature in the mould is given at 1,230°, and for grey cast iron 1,350° C. Steel runs still higher, ranging from 1,500° to 1,600° C. An examination of the temperatures, therefore, gives an indication at once as to the requirements for linings and sands.

"Chemically, refractory materials vary, but usually contain silica, alumina, lime, magnesia, oxides of iron, or manganese, alkalies, soda and potash, etc. Silica, alumina, or lime, are alone very infusible, and will resist the highest temperatures attainable in foundry practice. However, for various reasons these materials cannot be used in a state of purity. The softening point of silica may be taken as about 1,830 degrees C.; alumina and lime are probably higher. But the three compounds which separately are extremely infusible may, on admixture, become more fusible. Boudouard, who has examined this matter from the point of view of slags, has arrived at a series of interesting results. Thus, silica softens at 1,830 degrees; if this silica is associated with 14½ per cent. alumina, the softening temperature is reduced to 1,690 degrees. Further increments of alumina and corresponding decrease in silica result in gradually raising the softening temperature, until at 37 per cent. silica and 63 per cent. alumina a softening point of 1,890 degrees is reached, which is some 60 degrees *above* that of silica."

With mixtures of silica and lime, giving rise to silicates of lime, the softening temperature falls from that of pure silica, until the proportion of silica becomes 60 per cent. and lime 40 per cent., after which, with the increase in the proportion of lime the softening temperature rises again. Triple combinations of silica, alumina and lime are comparatively fusible, falling below 1,400° C., or lower than some of the mould temperatures in the foundry.

The resistance to heat is but one of the properties which should be possessed by a furnace lining or a moulding sand, and it is connection with the working qualities of a refractory material that practical experience in the foundry must be taken into account.

"Furnace linings have, in addition to high temperatures, to resist one or more of the following conditions:—(1) Expansion and contraction, due to alternate heating and cooling; (2) the cutting action of flames, the abrading effect of molten metal, and the searching action of metallic oxides or scouring slags; (3) reducing or oxidising atmospheres in the furnace; (4) mechanically the lining must withstand the wear and tear of charging solid metal. With regard to the action of slags, we have already seen that silica and lime, when in contact at elevated temperatures, unite and form a silicate which fuses at a comparatively low temperature. Therefore, if the lining of the furnace is siliceous and the slag contains much lime, this lime will unite with a portion of the silica of the lining and form a fluid slag."

Mr. Longmuir divides refractory materials into three classes: acid, neutral, and basic. The acid materials contain an excess of silica which, acting as an acid, will combine with various bases to form a fusible silicate. Silica sand, containing 94 to 96 per cent. of pure silica, is very infusible, and is employed to form the bed of the open-hearth furnace. Since this sand possesses no bond it cannot be rammed into any permanent shape, in when used for the bed of a furnace it is applied in successive layers, each layer being fritted, or raised to such a temperature that it becomes slightly fused.

When it is necessary to use a siliceous material in a definite form, some such material as ganister, containing from 90 to 95 per cent. of silica and the balance clayey matter, is employed, this when ground, being capable of ramming into form for lining cupolas, Bessemer converters, etc.

Basic refractory materials are not very extensively used in the foundry, as they are not so readily manipulated as acid linings. They are used only when the slags of the process are of such a character that they eat into, or unite with an acid lining. The commercial basic materials used are composed of lime or magnesia or a combination of the two. Neutral materials find application as intermediate layers between the acid and basic portions of a furnace. Such neutral materials are chromite, carbon, or most frequently, fireclays. Fireclays are essentially hydrated silicates of magnesia, containing, before burning, 46.5 per cent. of alumina, 39.5 per cent., combined water 14 per cent. The presence of the combined water produces the plasticity of the clay, and after burning this water is wholly driven off. Impurities may be present in the form of magnesia, lime, oxide of iron, and alkalies, and in any case the alkalies should not exceed more than 1 per cent.

Considering moulding sands, these have to resist heat, furnace atmosphere, and the action of liquid slags and metals. If resistance to heat were the only property necessary the value of a sand might be determined from its chemical composition, and be considered as dependent upon the content of silica.

"A consideration quite apart from temperature is, however, found in the *searching* action of liquid metals. It can be taken as an axiom that the greater the fluidity, the greater the penetration into the mould. For example, we may take a series of moulds, prepared from one batch of sand, all equally rammed, and all in the same condition as regards moisture, but none of them faced. We will assume that the sand is in a moderately fine state of division, such as would be usual for a cast-iron mould, and that it contains 84 per cent. silica. Into one mould fluid cast iron is poured at a temperature of 1,350° C. A certain amount of sand will stick to the cold casting, but it will permit of removal by a wire brush. Into another mould mild steel, at a temperature of 1,600° C., is poured, and from the cold casting adhering sand will not permit of removal by a wire brush. It will, in fact, have fused into a silicate of a more or less glassy nature, and will require chipping off. This is purely a temperature effect, but turning to the other extreme, and taking an example from lead, it will be found that a casting poured at 400° C. will come out with a perfectly smooth skin. If another casting is poured at 675° the sand will adhere most tenaciously and the casting be full of veins. The adhering sand will give every appearance of being burnt—if not actually fused—yet the temperature is only half that of cast iron, which at 1,350° would yield a smooth casting. Although not actually a fusion of the sand into a silicate, the difficulty in dressing the casting is as great. Probably the most common example of searching is found in phosphor bronze, which at a normal temperature is extremely fluid, and will penetrate into the pores of a mould, binding the individual grains of sand into a dense and compact mass—a fact very familiar to brass founders, and one readily appreciated by the dressers.

"Therefore, in certain cases, a moulding sand must resist, not only temparature, but also the penetrating action of a thinly fluid metal or alloy. Of necessity, this latter property must be associated with porosity in the sand. Could an impervious mould be used there would be no difficulty in arresting penetration. However, the substance of the mould must be of such a nature as to offer a free escape for the gases generated on casting. Further, the sand, when rammed into shape, should be firm to resist liquid pressure, and strong to resist the washing action of a stream of molten metal. These do not constitute all the desirable features of a sand; incidentally it should give a clean, smooth skin to the casting and be readily removed from it.

"Reverting to the chemical composition of sands, they are found to contain—in addition to silica—varying amounts of alumina, magnesia, lime, and metallic oxides. Alumina increases the cohesion of a sand—that is, its binding qualities—but at the same time it destroys porosity. Lime and metallic oxides, if in excess, increase the fusibility—hence, destroy heat-resisting properties. Soda and potash are equally harmful in this respect, but they are not usually present in dangerous quantities."

AMERICAN COKE MAKING.

RECENT DEVELOPMENTS IN COKE PRODUCTION IN THE UNITED STATES TO MEET PRESENT AND FUTURE REQUIREMENTS.

Edward W. Parker—Iron Age.

IN the iron and steel industries in the United States there has been such a great productive activity during the past year as to influence to a marked degree such other lines of industry as bear any relation to the iron manufacture. Thus the production of coke in the United States during 1905 exceeded that of any previous year, all the old regions having been pushed to their maximum capacity, while new areas of coking coal have been developed. This whole subject of coke making in the United States is treated in an article in a recent issue of the *Iron Age,* by Mr. Edward W. Parker, of the United States Geological Survey, from which some abstracts will be found of interest, as bearing directly upon the iron and steel industry.

"It is an open secret that at the present rate of production the Connellsville basin will be exhausted in from 25 to 30 years, and even this brief term of life will be shortened by an increasing drain upon the reserves. The Connellsville basin is estimated to have contained originally 137 square miles, or 87,700 acres, of the Pittsburgh bed, which here has an average thickness of about 7 feet. Estimating 1,100 short tons to the foot acre and a recovery of 90 per cent., which is said to be attained, the total available supply when production began was about 600,000,000 net tons. About one-third of the coal has already been worked out, so that, say, from 55,000 to 60,000 acres, or approximately 425,000,000 net tons, remain unmined. During the last five years the coke production of the Connellsville region has averaged 10,000,000 net tons, equivalent to 15,000,000 net tons of coal. At this rate, exclusive of any of the coal sold or used at and near the mines in operating the properties the entire bed will be exhausted inside of 30 years.

"But while Connellsville coal is the ideal coking coal particularly for beehive ovens and although this region has for many years produced over 50 per cent. of the total coke product of the United States there is no reason why ironmasters and other coke consumers should feel any apprehension as to their supplies of fuel when Connellsville coke shall have ceased to be a factor in the trade. There are still large areas of good coking coal lands practically untouched throughout the Appalachian field and the active development which has been in progress during the past year in the other coke producing regions indicates that provision is being made for future requirements."

Mr. Parker reviews the development of other regions in Pennsylvania, and also in West Virginia, with an excellent map, and he also refers to the existence of fields in Kentucky, where vast areas of high grade coking coals are only waiting for railroad facilities to be placed in the market.

Apart from the sources of coking coal, and important question at the present time is the introduction of modern by-product coke ovens, and the utilization of the gas by pipe-line transmission to more or less distant places.

"As a producer of illuminating gas the by-product coke oven has steadily gained ground. The method of separation of gases is now generally recognized as the most advantageous system. This consists in dividing the gas evolved from the coal into two portions, the first part being of higher illuminating and calorific value, known as the "rich" fraction. The second portion is of lower quality and is known as the "poor" or fuel portion. It is used for heating the ovens, which by their construction are necessarily heated by gas, though not necessarily by their own gas. The rich gas is available for illuminating or other purposes and comprises from 30 to 50 per cent. of the total volume of gas obtained from the coal, varying with the quality of the latter. Compared with ordinary coal gas it is usually of equal or better illuminating and calorific value, although not made from gas coals, this being due to the method of fractional distillation, by which only the best of the gas is taken.

"One handicap to the advantageous disposal of by-product coke oven gas has been that where ovens have been built for supplying coke to blast furnaces the immediate vicinity of the plant did not have population enough to absorb the disposable gas. Under such circumstances the long distance transportation of gas in pipe lines under pressure has come into use.

"Gas from by-product coke ovens at the plant of the Maryland Steel Company at Sparrow's Point, Md., is now regularly pumped to Baltimore through a pipe line about 9 miles in length under a pressure of approximately 5 pounds and under all weather conditions. Between 4,000,000 and 5,000,000 cubic feet per day is thus delivered to Baltimore, forming a large portion of the total illuminating gas consumption of that city.

"Gas from the by-product ovens of the South Jersey Gas, Electric & Traction Company at Camden is now regularly pumped through pipe lines to Trenton, N. J., a distance of 38 miles, under an initial pressure of about 10 pounds. This is accomplished without any appreciable drop in the illuminating value of the gas after transportation, even under extreme weather conditions.

"The Camden plant is also notable as being the first to install the process of gas enrichment by benzol transfer on a large scale. This process has been developed by the United Coke & Gas Company and consists in removing the benzol from the 'poor' or 'fuel' fraction of the gas by scrubbing with tar oil. The benzolized oil is then subjected to fractional distillation in a still through which a current of rich gas passes and the highly benzolized gas is mixed subsequently with the main volume of 'rich' or illuminating gas, thus adding to the illuminating power of the latter by some 4 or 5 candle-power. As the enrichment is made by practically pure benzol it is said to be permanent in its character at the temperatures and pressures prevailing in a gas distribution system; the enriched gas therefore reaches the consumer with all of its illuminating value. The process also possesses advantages because of the simplicity and low operating cost of the apparatus, and as it uses the benzol already at hand the enrichment is obtained for practically the nominal operation charges.

"In the construction and operation of the by-product oven the advances made have been of a minor character, affecting the details of the process. The oven capacity has been gradually increased, the dimensions added to being those of height and length rather than width. The process of compressing the coal into a cake, which is charged into the oven in one piece through the end instead of filling the loose coal in at the top charging holes, has not grown in favor, principally because of its high cost of installation, slow operation and the trouble with freezing in winter.

"Numerous improvements have been made in the machinery accessory to the by-product ovens, among them being a new form of coke quencher, in which the coke is quenched and loaded into cars by one man, the quenching water being applied in a closed receptacle, so that the silver-gray color of beehive coke is reproduced and at the same time excessive moisture in the coke is avoided."

The by-product coke ovens at present used in the United States are of the Otto, Otto-Hoffman, and Semet-Solvay types, and there are now built and under contract 2,380 United-Otto ovens and 1,255 Semet-Solvay plants, so that it is evident that the by-product coke oven is making rapid headway in America.

IMPACT TESTING.

THE STUDY OF THE RESISTANCE OF MATERIALS TO SHOCK BY THE DROP TEST UPON NOTCHED BARS.

Capt. H. Riall Sankey—The Engineer.

DETERMINATIONS of the resistance of materials of construction by subjecting specimen pieces, representing more or less correctly the larger quantities actually to be used in construction, are now very general, and the large amount of study which has been given to this subject entitles it to be considered as a distinct department of engineering research. Formerly it was considered sufficient to determine the ultimate tensile resistance of most materials, and even yet there is a disposition to reduce many other properties to functions of the tensile strength, and thus deduce values which are much better determined directly. Especially has there appeared of late a tendency to introduce dynamic tests, as auxiliary, at least to the static tests which preceded them, and in view of the shocks and vibrations to which actual structures are subjected, some direct knowledge of the behaviour of materials under shock is most desirable.

Drop tests, such as those made upon railway axles, and similar products, have long been used, and these have the material advantage that they are made upon piece representing the actual finished product. Such tests, however, include the delivery of many blows upon the piece, and involve a large apparatus, take much time, and do not give all the information which is desired. For this reason there has been applied of late another method, using small test pieces, usually with a nick or notch in the surface of the metal, to localize the action of the blow, the size of the piece and the weight and height of the drop being so chosen that the test piece is fractured by a single blow. By measuring the energy in the falling weight before and after the fracture of the test piece the quantity of energy required to effect the break may be accurately computed, and definite and quantitative information thus secured. This method is analogous to that sometimes employed in studies of the resistance of armor plate, the test plates being made thin enough to insure that the projectile shall pass clear through, this permitting the use of the chronograph for the measurement of the velocities of the shot just before impact and immediately after penetration, the resistance of the plate being thus measured by the retardation produced upon the velocity of the projectile.

In a recent issue of *The Engineer,* Captain H. Riall Sankey examines the practical uses of the one-blow drop-test system as a means of determining the properties of various steels, and shows the advantages of the system in connection with the resistance of such materials to shock. Captain Sankey does not believe that the shock test alone is sufficient to give all the desired information about a material, however, but insists that a tensile test, or its equivalent, should also be made.

The fundamental difference between impact testing and statical tests is that in the former case the elastic stresses of the material are necessarily exceeded, and in the one-blow method there must be an excess of energy to insure that the breaking stress be reached; this, in reality, being the essence of the method.

"In the many-blow method the elastic stress must be considerably exceeded if the specimen is to be broken with a reasonable number of blows; and it is further evident that the amount of this excess will very greatly affect the number of blows. From the standardisation point of view a difficulty of the many-blow method is thus made apparent, for obviously it will be difficult to co-ordinate the results of machines having different energy in the blow, and different sizes of specimens combined with varying strengths of steel. Suppose, for instance, that a certain specimen breaks with twenty blows when the elastic limit is exceeded by 20 per cent., how many blows would be required if the energy of each blow were reduced so that the excess were only 5 per cent.? No doubt a far greater number of blows, but how many more it is difficult to say."

The use of a notch in the top of a test piece, at the point where the blow is delivered, has two effects; making the rupture of the piece with a single blow more certain, and especially revealing tendencies to brittleness which might not otherwise appear. It has long been known to the shop mechanic that a bar which could be bent over the edge of the anvil by several blows, would break off short with a single blow if first notched with a file, the fracture in the latter case often appearing granular and quite different to the fibrous nature of an ordinary bending test. The realization of this fact leads every careful designer of machinery to avoid sharp angles and corners in parts subjected to vibratory or sudden stresses, and hence a similar course of reasoning indicates that the behaviour of the material under just such conditions is a good thing to investigate. Many mild steels, which appear ductile under tensile stress are in reality brittle under shock, while it may well be accepted that a material which shows up well under the drop test with a nicked bar is a desirable substance for use in structures subjected to vibration.

"It will probably be conceded that owing to the suddenness of the rupture with the one-blow method with notched test piece that there is insufficient time for the molecules to become displaced, and that therefore the fracture is an index of the molecular, or, perhaps, more strictly, of the molar structure of the steel, and this in itself is a most valuable feature of this method of impact testing, and the writer has no hesitation in saying that the appearance of the fracture is of the greatest assistance in deciding on the quality of the steel. This statement is undoubtedly also true of the fractures obtained with the many-blow method, but the difference between the various fractures is not so well marked, and the fracture cannot well represent the actual fracture of the steel, because the molecules will have time to become displaced, and the final structure will be that due to the modification of the structure of the steel produced by the effect of the successive blows. It is not difficult to conceive that owing to some particular heat treatment the molecules of a steel of good composition may be so arranged as almost, but not quite, to form a structure capable of resisting shock. The structure may, in fact, be in a condition of partial unstable equilibrium, which would be upset by a blow; thus the steel would be in a brittle condition, and would break readily if subject to a blow of sufficient magnitude, as would be the case if tested by the one-blow method. A small blow, however, might have the effect of slightly displacing the molecules and bringing them nearer to the positions required for a structure capable of resisting shock. In the case thus conceived the effect of the successive small blows of the many-blow method of impact testing would be gradually to improve the structure of the steel so that it would resist a great number of blows, and would appear to be of good quality."

Captain Sankey tabulates data and results of a number of tests upon steels of different kinds, giving the heat treatment and results of tensile tests, together with the behaviour of the same materials under the single blow drop test, and shows how the latter system enables the materials to be classified into groups denominated respectively brittle, tough, and very tough, enabling selection to be made in accordance to the use to which the material is to be applied.

OUTSIDE WORK BY ENGINEERING PROFESSORS.

THE POLICY OF PERMITTING THE CONDUCT OF INVESTIGATIONS AND COMMERCIAL TESTS IN CONNECTION WITH THE WORK OF AN ENGINEERING COLLEGE.

D. S. Jacobus—American Association for the Advancement of Science.

FOR a long time there has been a difference of opinion among technical educators as to the propriety or desirability of the undertaking of outside and private scientific investigations by college professors. The trustees or governing bodies of educational institutions have, in the great majority of cases, held that the institution is entitled to the whole time of the instructor, and that any attention given by him to work other than the direct tuition of students is that much effort diverted from the work for which he is paid by them. Of late, however, it has been realized that there are two sides to this subject, and at the present time the practice is by no means uniform in all institutions, although many people who have to do with the matter hold very decided opinions upon one side or the other. For this reason the thoughtful address, delivered by Professor D. S. Jacobus, as vice-president of the American Association for the Advancement of Science, and chairman of the section devoted to mechanical science and engineering, is to be welcomed. The address is published in a recent issue of *Science,* and from it we take occasion to review some of the salient points.

Professor Jacobus assumes at the start what few will now be inclined to dispute, that a professor in any department of applied science should have a practical as well as theoretical acquaintance with the subject which he has to teach. This practical experience may be acquired in three ways: by having been a practical man, in active exercise of his profession before undertaking work as a professor; by interpolating, so to speak, a period of active practice between two engagements as a professor; or, by carrying on practical work simultaneously with his professorial duties.

As Professor Jacobus remarks, each method possesses its own advantages and disadvantages. Undoubtedly many able instructors have gained their experience in the practical field before entering the teaching profession. A notable example in this case is found in the late Professor Reuleaux, who, after a thorough technical and literary education, entered the machine shop, and rose to be a manager before becoming a professor at Zurich. At the present time such a method is not common, largely because a man of sufficient ability to fill any important professorial chair can make a far greater reward in the practice of his profession than the salary paid by educational institutions, besides which it is difficult for a man who has matured in the practical field to adapt himself well to theoretical methods. The same difficulties which prevent the general adoption of the first plan also appear in the second. A professor who enters the practical field may well acquire the experience which would fit him still better for his work as an instructor than formerly, but in the great majority of cases he finds the new field so much more profitable than the old one that he has no desire to return.

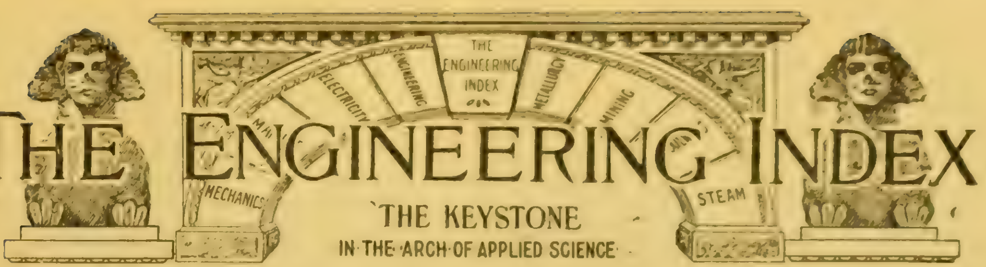
There remains then the third method, that in which the professor undertakes outside professional work, in parallel, so to speak, with his duties in instruction. That there have been objections to this method is a well-known fact, but such objections do not appear to be altogether well founded. If a professor neglects his work of instruction for the conduct of outside professional work he is certainly not the man for the chair which he neglects, but such instances are few. A professor who is energetic enough to take upon him the additional labor of outside work is apt to be a worker in everything. As Professor Jacobus says: "The professor must exert himself to the utmost to secure the best results with his students and when this is done, there is no harder way than by the undertaking of outside work, and if the professor is an enthusiast there is often much danger of his breaking down under the strain. On the other hand, if he manages to secure an experience which will give him the reputation of being an authority in his field, he usually will make the best sort of a teacher, and be a credit to the college with which he is connected."

"In all that has been said so far it is assumed that it is necessary for certain professors to have an experience in the outside field. I do not think any one will question this. One is apt to get into a rut in teaching and to have his mental horizon narrowed so that he cannot perceive his own faults, and there is no better way of expanding this horizon than to be a co-worker with practical men. The main advantage that a practical teacher has over one who is purely theoretical is that he can make his course interesting by the introduction of practical examples, and in this way incite the students to study intelligently, which is the real measure of his success. He may, however, make the mistake of introducing too many practical details into the course. It is essential above all that the fundamentals of the subject shall be mastered, and the true use of practical problems, aside from securing the interest of the class, is to show that their solution is based on a few broad underlying principles. A practical man may also make a mistake in thinking that his way of looking at a problem is so simple and straightforward that it will surely be grasped by the students. In teaching, however, he will find that after presenting a subject in what he considers a way that all must understand, there will be many, possibly the majority of the class, that have failed to grasp the reasoning. Men's minds work differently, and the path taken to arrive at the understanding of a problem will vary, so that unless a subject is presented in several ways the explanation given by a professor may fail to fall into the line of thought of many of his students, and he will be disappointed in the results obtained.

"It is a fact, however, that there are many professors who have had little or no outside experience. This often occurs where a young man enters the profession of teaching directly after his graduation, and is placed in such a position that it is impossible for him to undertake any practical work. Such a professor may make the best sort of a tutor, and may be most successful in imparting the fundamentals of a subject, but when it somes to being put in charge of a practical engineering department, it is here that his lack of experience will be very much felt. In a certain sense it is unfair for a head professor to secure the services of a recent graduate and keep him continually at teaching so as not to allow him to gain outside experience."

There is one point about this matter of outside work by professors which is not always considered by trustees and others who object to the practice. If a man is so highly esteemed by business men and others who are obliged to secure professional advice and assistance that his aid is sought, he must be a man of superior attainments and ability, and the educational institution may well deem itself fortunate to secure his services at all. The old law of supply and demand asserts itself here as elsewhere, and the man who is wanted by nobody else is not likely to be the best man for the professor's chair. The educational institutions must permit their abler professors to keep themselves up in the active practice of their professions, or else face the certainty of losing them altogether.

"It has been claimed that the professors of an engineering college should not do work in the practical field, as this interferes with the consulting engineers who depend for their livelihood on just the sort of work that would be apt to be undertaken at a college. This is a very narrow view to take of the matter, and as far as my own personal experience is concerned, I can testify to the fact that much of the work undertaken in connection with my college duties has been done for consulting experts. The day is past when there can be a strict line drawn between the work of the consulting engineer and that of the professor who teaches in the same field. The ideal professor in a given line should be able to take up the work of the consulting engineer in that line, and the ideal consulting engineer should possess enough technical knowledge to fit him for being a professor. There should be no jealousy, but rather a bond of friendship in that the fundamentals which each should master are the same."



THE ENGINEERING INDEX

THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING

BRIDGES.

Abutments.

The Design of High Abutments. William M. Torrance. Illustrated description of interesting work in connection with double-tracking the Cairo bridge, across the Ohio River; Illinois Central R. R. 3300 w. Eng News—Jan. 11, 1906. No. 74333.

Accident.

Displacement of the Semi-Arches of a Stone Bridge. Illustrated description of an accident during erection of the Maximilian bridge at Munich. 2000 w. Engr, Lond—Dec. 29, 1905. No. 74300 A.

Arches.

A Graphostatic Examination of Flat Parabolic Arches (Graphostatische Untersuchung des Flachen Parabelgewölbes) Dr. Josef Schreier. A comparison of the graphical and analytical methods of investigating the stresses in masonry arches, taking the parabola as the curve of equilibrium. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 22, 1905. No. 74618 D.

Eye-Bars.

New Facts About Eye-Bars. Theodore Cooper. States some incorrect assumptions that are generally accepted, describes an investigation carried out in connection with the erection of the Quebec Bridge, giving tabulated results, with their practical consideration and application. 4000 w. Pro Am Soc of Civ Engrs—Jan., 1906. No. 74702 E.

New York.

Main Vertical and Inclined Posts, Island Span, Blackwell's Island Bridge. Illustrated description of interesting details in the construction of this bridge across the East River, at New York City. 1500 w. Eng Rec—Jan. 27, 1906. No. 74769.

The Lower Chords of the Island Span of the Blackwell's Island Bridge. Illustrated description of the riveted bottom chords of the island span of the bridge across the East river at Blackwell's Island, New York City. 1200 w. Eng Rec—Jan. 6, 1906. No. 74274.

Nile.

The Nile Bridge at Cairo. Illustrations, with description of the construction work. 1000 w. Engng—Jan. 12, 1906. No. 74522 A.

Plate Girders.

Standard Plate Girders on the Chicago, Milwaukee & St. Paul Ry. Illustrated detailed description of the girders for shallow floor through plate girder bridges. 1800 w. Eng Rec—Jan. 20, 1906. No. 74501.

Railway Bridges.

Some Notable American Railway Bridges. James G. Walton. Illustrates and describes recently erected examples of steel bridge building as practiced in the United States. 100 w. Cassier's Mag —Jan., 1906. No. 74461 B.

Rhine.

The New Bridge over the Rhine at Bâle (Die Neue Basler Rheinbrucke). E. Gutzwiller. A general description of the new masonry arched bridge, with numerous illustrations. Serial. Part I. 1500 w. 1 plate. Schweiz Bauzeitung—Jan. 6, 1906. No. 74666 B.

Strengthening.

The Strengthening and Maintenance of Early Iron Bridges. William Marriott. Describes the measures adopted for the strengthening of two bridges built in the sixties and seventies, in order to adapt them to modern requirements and to protect them from rust. Discussion. Illus. 14500 w. Inst of Civ Engrs. (No. 3554.) No. 74356 N.

Substructure.

Substructure of Potomac River Highway Bridge, Washington, D. C. An illustrated detailed description of the construction work. 2000 w. Eng. Rec—Jan. 27, 1906. No. 74770.

Zambesi.

The Bridge over the Zambesi River at the Victoria Falls in Rhodesia (Die Bogenbrücke über den Sambesi Fluss bei den Victoriafällen in Rhodesia). G. Barkhausen. A detailed illustrated description of the Zambesi bridge, including structural elements and erection. 4500 w. Zeitsch d Ver Deutscher Ing—Dec. 30, 1905. No 74604 D.

CONSTRUCTION.

Building Construction.

See Reinforced Concrete.

Building Design.

The Architecture of Continental Power Plants. Franz Koester. Illustrates and describes examples of European power plant architecture. 2000 w. Elec Wld—Jan., 1906. No. 74310.

Caisson Disease.

Compressed Air Illness; or, Caisson Disease. Thomas Oliver. Abstract of a lecture at the Roy. Inst. of Pub. Health, London. Describes a caisson, and the "compression" and "decompression" of workmen, the admission of pure air, and ventilation. The hygiene and symptoms are discussed, and the prevention and treatment of caisson disease. 4000 w. Min Jour—Jan. 6, 1906. No. 74411 A.

Columns.

The Theory of Continuous Columns. Ernest F. Jonson. Develops the exact theory of continuous columns in order to deduce from it a simple method of calculating the effect of eccentric loading, both at the floor level and at an intermediate point. 1600 w. Pro Am Soc of Civ Engrs —Jan., 1906. No. 74701 E.

Concrete.

Concrete Construction for the B. T. Babbitt Works. Illustrates and describes the construction of extensive works for the manufacture of soap, about nine miles from Jersey City. 1400 w. Eng Rec—Dec. 30, 1905. No. 74138.

Legal Requirements in Regard to Concrete Building Construction. Rudolph P. Miller. Abstract of a paper read at the meeting of the Nat. Assn. of Cement Users. Discusses the quality of the cement and associated material, legal requirements for workmanship, etc. 4000 w. Eng News—Jan. 25, 1906. No. 74567.

Retempered Mortar in Concrete Work. Ernest McCullough. Information concerning excellent results obtained by an old English mason, especially in patching and repairing old concrete. 1000 w. Eng News—Jan. 11, 1906. No. 74331.

Dams.

Completion of the New Croton Dam. An illustrated article giving information in regard to the methods of construction, cost, and design of this important work. 2500 w. Eng Rec—Jan. 6, 1906. No. 74275.

Internal Stresses in Masonry Dams. S. D. Bleich. Walls containing water only are considered as illustrative of all others. A mathematical study of the distribution of shear along horizontal and vertical planes. 1200 w. Sch of Mines Qr—Nov., 1905. No. 74547 D.

Excavation.

A Machine for Excavating Narrrow Ditches (Maschine zum Ausheben Schmaler Graben). Eugen Eichel. Describing an American apparatus using a revolving wheel carrying excavating buckets for digging ditches for drain pipes. 1000 w. Zeitscher d Ver Deutscher Ing—Jan. 13, 1906. No. 74612 D.

Methods and Cost of French Excavation with a French Digging Machine. Halbert P. Gillette. Gives cost data relating to excavating trenches with a machine, showing that the work can be done at a cost that compares favorably with dredging and hydraulicing. 1800 w. Eng Rec—Dec. 30, 1905. No. 74136.

Frameworks.

The Graphical Determination of the Lines of Pressure in Framed Structures (Graphische Ermittlung der Einflusslinien für die Spannungen im Fachwerk). S. K. Drach. Discusssing especially the case of a three-hinged framed arch. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 29, 1905. No. 74620 D.

Fireproofing.

See Reinforced Concrete.

Fire Protection.

The Vienna Model Theatre for Fire Tests (Das Wiener Modelltheater für Brandversuche). H. Harder. An account of the tests made upon a model building to determine the best methods of protecting theatres against fire. 3000 w. Gesundheits Ingenieur—Dec. 20, 1905. No. 74669 B.

Foundations.

Foundations for Chicago Buildings. John M. Ewen. A short history of the foundations of Chicago buildings since the great fire, calling attention to the improvements made from time to time. Discussion. Ills. 4500 w. Jour W Soc of Engrs —Dec., 1905. No. 74553 D.

Rapid Construction.

Rapid Construction of an Industrial Plant. Illustrated description of the methods followed at the St. Croix Paper Company's Works, Spragues Falls, Me. 2000 w. Eng Rec—Jan. 6, 1906. No. 74273.

Reinforced Concrete.

A Reinforced Concrete Shoe Factory in Brooklyn. Illustrated description of an interesting example of factory design. 2500 w. Eng Rec—Jan. 20, 1906. No. 74503.

Fireproof Construction and Prevention of Casualties by Fire. H. F. J. Porter. In discussion of paper by E. N. Hunting before the A. S. M. E. Urges the development of a regular fire corps in factories and shops, fire drills, &c. 1700 w. Am Mach—Vol. 29, No. 1. No. 74209.

Notes on Reinforced Concrete. J. R. Worcester. Read before the Boston Soc. of Archts. Discusses the quality of the cement used, the advantage of reinforcement, the applications made of this material, the difficulties and disadvantages, &c. 4500 w. Am Archt—Jan. 6, 1906. No. 74230.

Reinforced Concrete Fence Posts. Philip L. Wormsley, Jr. Extract from Farmers' Bulletin, Dept. of Agriculture. Gives information concerning the construction recommended, and report of tests. Ills. 2500 w. Eng News—Jan. 18, 1906. No. 74458.

Reinforced Concrete. Harrison Albright. Points out some of the stumbling blocks which beginners are apt to meet in their first attempts in reinforced concrete construction, and the essentials to success. 1600 w. Cement—Jan., 1906. No. 74193 C.

Reinforced Concrete in Building Construction. Discussion by Messrs. Emile G. Perrot, Walter Loring Webb, C. A. Hexamer, James S. Merritt, and E. P. Cowell. Ills. 8000 w. Jour Fr Inst—Jan., 1906. No. 74549 D.

Reinforced Concrete Water Tower at Bordentown, N. J. Briefly outlines recent changes made in the water supply, and describes the tower. Ills. 2000 w. Eng Rec—Jan. 13, 1906. No. 74386.

The Reinforced Concrete Factories for the Bush Terminal. Illustrated detailed description of factories which are in process of construction in South Brooklyn. 2500 w. Eng Rec—Jan. 13, 1905. No. 74385.

U S. Naval Academy Chapel, Annapolis, Md. Illustrations, with brief description of this interesting example of the use of concrete in building operations. 1000 w. Cement—Jan., 1906. No. 74191 C.

See Civil Engineering, Materials.

Retaining Walls.

Concrete Retaining Wall and Tunnel. Herbert I. Bennett. Illustrated description of a tunnel through the Santa Cruz Mountains, which has stood eleven years without showing the least sign of cracks or other failure. 1000 w. Sci Am Sup—Jan. 13, 1906. No. 74391.

Heavy Concrete Retaining Walls, Illinois Central R. R. An illustrated description of the construction of a concrete retaining wall in connection with the improvements being carried out by the South Park Commissioners of Chicago. 2000 w. Eng Rec—Jan. 27, 1906. No. 74765.

Roads.

County Road Construction. A topical discussion. 4000 w. Pro Engrs' Soc of W Penn—Jan., 1906. No. 74541 D.

The Office of Public Roads. Excerpt from the report for 1905 of Hon. James Wilson, Secretary of Agriculture. Gives an idea of the work undertaken and the results attained up to the present time. 3800 w. Eng Rec—Jan. 27, 1906. No. 74771.

Roofs.

Temporary Structures in Wood (Halles Provisoires en Bois). A description of recent buildings in Switzerland, covered by timber roofs of large span. 1000 w. Génie Civil—Dec. 16, 1905. No. 74624 D.

The Charing Cross Disaster. Editorial on the verdict given at the coroner's inquest as to the cause of the disaster, showing that the roof collapsed owing to the breakage of a tie-bar which had a concealed flaw. Ills. 1500 w. Engng—Jan. 12, 1906. No. 74525 A.

The Lesson of the Charing Cross Accident. Editorial discussing whether iron and steel ought to be regarded as permanently trustworthy materials of construction. Gives drawings and a brief description of the main constructional features of the Charing Cross station, with added information. 4800 w. Builder—Dec. 23, 1905. No. 74123 A.

The Timbering of the Charing Cross Station Roof. Illustrations showing the work in progress at the station, with brief description. 600 w. Engng—Dec. 29, 1905. No. 74296.

Tunnels.

Construction of Indigo Tunnel, Western Maryland R. R. Describes the construction of this tunnel, driven through very dense rock which did not require timbering. The method of driving the lower heading first and then taking the remainder above in a single lift is explained. 1800 w. Eng Rec—Jan. 27, 1906. No. 74768.

Scranton Tunnel of the Lackawanna & Wyoming Valley. An illustrated description of this tunnel on the third-rail electric line between Scranton and Wilkesbarre, Pa. 800 w. R R Gaz—Vol. XL. No. 2. No. 74329.

MATERIALS OF CONSTRUCTION.

Brick.

Sand-Lime Brick. E. W. Lazell. Considers the materials, methods of manufacture, and the uses, reporting the results of tests. 2500 w. Pro Engrs' club of Phila.—Jan, 1906. No. 74532 D.

Cement.

Cement Production and Manufacture in the United States. Edwin S. Eckel. A detailed study of the cement industry in the United States; showing its rapid growth in recent years. 3000 w. Engineering Magazine—Feb. 1906. No. 74675 B.

Cement. Robert W. Lesley. A review of the cement industry for the year, the enormous growth of the production in the United States, the distribution, market, etc. 2500 w. Eng & Min Jour—Jan. 6, 1906. No. 74268.

Report of the Committee of the National Fire Protection Association on Cement for Building Construction. Remarks on the material, with report of tests made and the results. 3500 w. Cement—Jan. 1906. No. 74190 C.

The Development in the Uses of Cement Richard L. Humphrey. Presidential address before the Nat. Assoc. of Cement Users. Historical review. 2500 w. Eng. Rec—Jan. 27, 1906. No. 74766.

Concrete.

Concrete Aggregates. Sanford E. Thompson. Read before the Nat. Assn. of Cement Users. Enumerates the general principles which should be followed in the selection of sand and stone for mortar and concrete, and describes the method of testing aggregates and determining proportions. 3500 w. Eng Rec—Jan. 27, 1906. No. 74773.

The Action of Sea-Water upon Concrete. J. Watt Sandeman. Gives a record of results based on actual tests, and long experience in the construction of dock and pier works in concrete, concerning the standard proportions for concretes which enable them to permanently resist the action of sea-water. 1200 w. Engng—Jan. 5, 1906. No. 74414 A.

Concrete Blocks.

Principles of success in Concrete Block Manufacture. Louis H. Gibson. Discusses some of the reaons why this material is not more popular with architects and the public. Ills. 3000 w. Munic Engng—Jan, 1906. No. 74187 C.

The Manufacture of Concrete Blocks and Their Use in Building Construction. W. G. Hayne. Fifth prize paper. Discusses the location and design of the plant, its equipment, the materials used, methods, etc. 6500 w. Cement Age—Jan., 1906. No. 74315.

Corrosion.

Protection of Structural Work from Rust. Robert Job. Reports experiments showing that the greater the degree of fineness of the pigment, the greater durability of the service. 900 w. Am Mfr—Jan. 11, 1906. No. 74341.

The Action of Slightly Alkaline Waters on Iron. Cecil H. Cribb and F. W. F. Arnaud. Abstract of a paper read before the Soc. of Pub. Analysts. Shows that an action occurs, often equal to that which takes place in the absence of an alkali. 1200 w. Engng—Jan. 5, 1906. No. 74422 A.

The Corrosion of Fence Wire. Report of an investigation by the Department of Agriculture. 3000 w. Ir Age—Jan. 11, 1906. No. 74305.

Lime.

The Rapid Volumetric Determination of Lime. Richard K. Meade. Outlines a rapid method applicable to materials in which the lime is present as either oxide, carbonate or silicate. 1000 w. Am Mfr—Jan. 11, 1906. No. 74342.

Piles.

New Concrete Covering for Timber Piles in Teredo-Infested Waters. Briefly refers to the forms of protection used, and the objections to them, and gives an illustrated description of a lock-joint concrete pipe armoring. 600 w. Eng News—Jan. 4, 1906. No. 74177.

Recent Improvements in Piles. An illustrated article showing what is being done by means of concrete, and steel and concrete, to supersede the old wooden piles. 2200 w. Engr, Lond—Jan. 19, 1906. Serial. 1st part. No. 74753 A.

Plaster.

Lime vs. Gypsum Plaster. R. S. Edwards. First prize paper. Aims to show the advantages in the use of large quantities of lime, and the ill effect caused by too large percentages of gypsum plaster. 3500 w. Cement—Jan, 1906. No. 74192 C.

Reinforced Concrete.

A new method of Calculating the Proportions of Reinforced-Concrete Structures (Nouvelle Méthode de Calcul des Ouvrages en Béton Armé). Col. G. Espitallier. Describing methods and results of tests showing measurements of the actual elasticity of the metal and concrete, with computations based thereon. 2500 w. Génie Civil—Jan. 6, 1906. No. 74634 D.

Armored Concrete. Henry J. Jones, in *Technics*. Discusses the economy of this material and its value, the systems and methods, giving information concerning its use. Ills. 2200 w. Sci Am Sup—Jan. 13, 1906. Serial. 1st part. No. 74389.

Bending Tests on Reinforced Concrete Beams (Biegungsversuche mit Armierten Betonbalken) E. Mörsch. Giving diagrams of deflections and extensions, showing the relative action of the concrete and metal. 2000 w. Schweiz Bauzeitung—Dec. 16, 1905. No. 74665 B.

Forms of Concrete Reinforcement. Illustrated discussion of the forms of metal most widely used for reinforcement. 4300 w. Ir Age—Jan. 11, 1906. No. 74304.

Shear and Adhesion in Reinforced Concrete. Editorial discussion of this material, its uses and limitations; suggesting lines along which experimental investigation is still needed, and giving conclusions arrived at from recent tests by J. J. Harding, and remarks on the lessons taught by them. 3000 w. Engng—Jan. 5, 1906. No. 74420 A.

Some Further Tests of Reinforced-Concrete Beams, C. M. & St. P. Ry. J. J. Harding Describes tests made by the Bridge & Building Dept. of the road named with a study of the results and statement of conclusions. General discussion. Ills. 10500 w. Jour W Soc of Engrs—Dec, 1905. No. 74554 D.

See Civil Engineering, Construction.

Testing.

Some Experiments on the strength of Brickwork Piers and Pillars of Concrete. William Charles Popplewell. Describes experiments carried out in the vertical 750-ton compression testing-machine, at the Municipal School of Technology, Manchester. 4000 w. Eng News—Jan. 4, 1906. No. 74171.

Timber Treatment.

The Inspection of Treatment for the Protection of Timber by the Injection of Creosote Oil. Discussion of paper by H. R. Stanford. 5500 w. Pro Am Soc of Civ Engrs—Jan, 1906. No. 74704 E.

Wire Rope.

Notes on the Theory of Wire Rope (Beiträge zur Theorie der Drahtseile). Dr. Hans Benndorf. A continuation of the author's studies in July, 1904, comparing the computed elasticity of wire ropes with the results obtained by experiment. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 15, 1905. No. 74617 D.

MEASUREMENT.

Field Instruments.

Repairing Engineers' Field Instruments. E. M. Douglas. Suggestions for making temporary repairs and for the care of instruments. 1600 w. Eng News—Jan. 25, 1906. No. 74564.

MUNICIPAL.

Fire Hazards.

Fire Hazards and How to Avoid Them. Washington Devereux. A statement of existing conditions from the fire hazard standpoint, with suggestions for care and construction of buildings. 5500 w. Cassier's Mag—Jan., 1906. No. 74462 B.

Fire Service.

Electricity in the Service of the Fire Brigade. Frank Broadbent. Reviews some applications that have already been noticed, and remarks that the chief difficulty is in obtaining a supply of electricity near the scene of the fire. 1800 w. Elec Rev, Lond—Jan. 19, 1906. No. 74737 A.

Garbage.

Garbage Disposal. Joseph G. Branch. Advocates incineration in preference to reduction for city refuse. 900 w. Munic Jour & Engr—Jan., 1906. No. 74133 C.

Municipal Improvements.

A New Year's Survey of Municipal Conditions. Editorial on the great increase in facilities that were formerly confined to large cities, and the number of industries owned municipally. Discusses also various classes of work done by municipalities, and the recent progress. Considers the outlook most promising. 4000 w. Eng News—Jan. 4, 1906. No. 74175.

Pavements.

Street Pavements in Chicago. John W. Alvord. Describes past and present conditions of the streets, and considers the progress and future outlook. 2000 w. Jour W Soc of Engrs—Dec., 1905. No. 74552 D.

Sewage.

Sewage Purification, with Notes on English and German Works. Charles F. Mebus. Principally a discussion of English works, with brief notes on German works. General discussion. 6000 w. Pro Engrs' Club of Phila—Jan., 1906. No. 74533 D.

The Scientific Disposal of City Sewage: Historical Development and Present Status of the Problem. C. E. A. Winslow. Discusses briefly the various methods tried in both Europe and America, and gives the opinion that only experimentation in each case will determine what method is most desirable. 6500 w. Tech Qr—Dec., 1905. No. 74584 E.

The Sewage Purification Works at Columbus, Ohio. Julian Griggs. Illustrates and describes the purification works to be built as a result of the investigations during one year to ascertain the most efficient and economical method of purifying the dry weather sewage flow. The method comprises septic tanks, sprinkling filters and settling basins. 3800 w. Eng Rec—Dec. 30, 1905. No. 74135.

The Tankage of Sewage. F. Wallis Stoddart. Read before the Roy. Inst. of Pub. Health. Discusses the causes of offensive odors. Tank capacity, secondary deposits, rate of flow through tank, and sludge disposal are considered. 5000 w. Munic Engng—Jan., 1906. No. 74188 C.

West Riding Rivers. Begins a detailed history of the Bradford sewage disposal question, showing the difficulties of the West Riding Rivers Board in its struggle against river pollution. 4000 w. Engng—Jan. 10, 1906. Serial. 1st part. No. 74745 A.

What Methods Are Most Suitable for Disposal of Sewage on the Atlantic Coast? George W. Fuller. Address at meeting of the New Jersey Sanitary Assn. Considers briefly recent additions to the evidence upon the subject of sewage disposal, and the practical conclusions now available. 3000 w. Eng News—Jan. 25, 1906. No. 74566.

Sewers.

Breakage in Sewer Conduits: Its Cause, Effect and Prevention. Alexander Potter. Gives information based on a study of the Joint Trunk Sewer in New Jersey. Also discusssion. 9500 w. Jour Assn of Engng Socs—Dec., 1905. No. 74379 C.

Outfall Works and Inverted Siphons for the New Sewerage System at Hamburg (Die Versenkung der Dükerrohre durch den Niederhafen und die Mündungsanlage der Neuen Stammsiele in Hamburg). Curt Merckel. Describing especially the construction and sinking of the inverted siphons for the new drainage system of Hamburg. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 13, 1906. No. 74609 D.

The Sewerage of Springfield, Ohio. W. H. Sieverling. The proposed works are described and illustrated. 1700 w. Munic Jour & Engr—Jan., 1906. No. 74134 C.

Street Traffic.

Expert Report on San Francisco's Street Traffic Problems. An illustrated article describing the scheme outlined by William Barclay Parsons for the development and improvement of the city's transportation and street traffic arrrangements. Also editorial. 10000 w. St Ry Jour—Jan. 6, 1906. No. 74227 C.

WATER SUPPLY.

Bore Holes.

Borehole at Malvern. An interesting account of difficulties encountered and overcome in the work of sinking boreholes to increase the water supply of this English watering place. Describes the tools used, one of which became set at a depth of 740 ft. Ills. 1500 w. Engr, Lond—Jan. 19, 1906. No. 74756 A.

Coolgardie.

Coolgardie Water Supply. Charles Stuart Russell Palmer. Gives briefly the history and topography of the district, with illustrated description of the design and construction of the works undertaken for the water supply of this district in Western Australia. Discussion. 65000 w. Inst of Civ Engrs (No. 3516). No. 74369 N.

Dams.

See Civil Engineering, Construction.

Filters.

Cleaning the Old Sand Water Filters at Hudson. An account of the method of cleaning, which had to be done very economically and with a limited supply of water. 2000 w. Eng Rec—Jan. 20, 1906. No. 74500.

High Pressure.

High Pressure Water Supplies for Fire Purposes. Points from a report of a committee of the National Fire Protective Assn. of special interest to water-works superintendents and engineers. 3000 w. Munic Engng—Jan., 1906. No. 74189 C.

Irrigation.

An Example of Irrigation in the Arid Regions of the United States. George Frederick Vollmer. A description of a typical irrigation scheme which has been carrried out by a private company called the Wyoming Development Company. Ills. 3000 w. Inst of Civ Engrs (No. 3553). No. 74353 N.

Lead Poisoning.

Plumbism Due to Electrolysis. Baldwin Latham. Read before the Brit. Assn. of W. Wks. Engs. Gives an account of a case of lead poisoning carefully investigated, and pronounced as entirely due to electrolysis. 2500 w. Elec Engr, Lond—Dec. 29, 1905. No. 74286 A.

New York City.

Water Hazards of New York City. Presents facts tending to show the pressing need of additional supply for the city, and information concerning the additional supply proposed. Editorial. 3500 w. Eng Rec—Jan. 13, 1906. No. 74387.

Pumping Station.

The District Pumping Station at Washington. W. A. McFarland. Illustrated description of the building and the present pumping equipment. 1800 w. Eng Rec—Jan. 20, 1906. No. 74499.

Reservoirs.

Note on the Underpinning of the Piers in the Reservoirs of the Galatz Waterworks, Roumania. Willliam Morris Langford. Illustrates and describes the manner of supporting the piers and their loads during repairs. 5000 w. Inst of Civ Engrs (No. 3551). No. 74352 N.

South Africa.

Port Elizabeth New Water Scheme. An illustrated article giving particulars of an important water scheme in South Africa, which is estimated to cost £360,000. It includes a dam and a new road on the Sand River, a dam tram line and new road in the Bulk River Valley, the pipe line, a tunnel, and a service reservoir. 2000 w. Engr, Lond—Jan. 19, 1906. No. 74755 A.

Water Tower.

See Civil Engineering, Construction.

WATERWAYS AND HARBORS.

Canals.

Canals Ancient and Modern. This first article of the series reviews the ancient history of the canals of various countries. 2000 w. Engr, Lond—Jan. 12. 1906. Serial. 1st part. No. 74528 A.

Cranes.

100-Ton Electric Wharf crane, Dublin Harbor. Illustration, with short description. 500 w. Engng—Jan. 19, 1906. No. 74747 A.

Dredges.

Russian Dredgers. A. Bormann. Read before the Milan Congress. Illustrated descriptions of dredges built entirely in Russia, by Russian firms. 4000 w. Naut Gaz—Jan. 11, 1906. No. 74365.

Harbor Works.

The Genoa Harbor Works. Reviews briefly the past history of the harbor works, and outlines the present scheme of enlargement. Plan. 2000 w. Engng—Jan. 19, 1906. No. 74744 A.

The Protection of Small Harbors on Lake Michigan. Notes from a report of a board appointed to inquire into the effect of wave action as injuriously affecting the harbors, and to suggest a plan of resisting this action. 4000 w. Eng Rec—Jan. 20, 1906. No. 74502.

Locks.

Canal Locks and Lifts (Ueber Schleusentreppen und Schiffshebewerke). Fr. Jebens. A comparison of locks in series with inclined planes and lifts for overcoming differences of level in canals. 1800 w. Glasers Annalen—Jan. 15, 1906. No. 74636 D.

Panama.

Proposed Excavation of the Panama Canal. by Floating Dredges. An illustrated article giving an outline of the plans proposed by Mr. Bunau-Varilla for the rapid construction of a high-level canal, and its final enlargement to a sea-level canal. 1300 w. Sci Am—Jan. 20, 1906. No. 74440.

Report of the Chief Engineer of the Isthmian Canal Commission. Portions of the report of Mr. John R. Stevens, which are of special interest to engineers. 5800 w. Eng News—Jan. 4, 1906. No. 74172.

Work on the Panama Canal. Brief outline of this project and the work that has been done, with many illustrations. 1200

w. Ry & Loc Engng—Jan., 1906. No. 74197 C.

Pier.

Viaduct and Pier in Reinforced Concrete at the Cala Mines, Spain (Viaducs et Appointement en BtonN4 - vu$5N-| m ciété des Mines de Cala, Espagne). Juan Manuel de Zafra. Illustrating a pier and approaches constructed on the Hennebique system of reinforced concrete, for handling iron ore at a railway terminus on the Guadalquivir, below Seville. 2000 w. 1 plate. Génie Civil—Dec. 23, 1905. No. 74627 D.

Ports.

The Port of London. Editorial discussion of the present condition of this port, and its needs. 3000 w. Engng—Jan. 19, 1906. No. 74749 A.

Ship Canal.

The East Bay Neck Ship-Canal, Tasmania. Charles Napier Bell. A brief description of a ship-canal across a peninsula on the east coast of Tasmania, for the use of coasting steamers and fishing craft. 300 w. Inst of Civ Engrs. (No. 3563.) No. 74351 N.

MISCELLANY.

Review.

Civil Engineering in 1905. An editorial review of the year briefly considering the progress in the different countries. 5000 w. Engr, Lond—Jan. 5, 1906. No. 74427 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Space Telegraphy.

Notes on a Wireless Telegraph System. C. C. F. Monckton. On the Trinidad-Tobago wireless system describing the working of the insulated Lodge-Muirhead sender. Ills. 2500 w. Elect'n, Lond—Jan. 12, 1906. No. 74518 A.

The Limiting Factors of Syntonic Wireless Telegraphy. J. Hettinger. Aims to show a method which permits the discussion of the practical value of syntony when the resonance curves are experimentally determined, and to prove that the resonance method, as utilized now, may be a partial solution for avoiding interference, but never can be a general one. 2000 w. Elec Engr, Lond—Dec. 22, 1905. No. 74139 A.

The Orling-Armstrong system of Wireless Telegraphy and Telephony. A. Frederick Collins. Illustrated detailed description of this system. 1500 w. Elec Wld & Engr—Dec. 30, 1905. No. 74166.

Telegraphy.

The Jones Phantoplex Telegraph System. Describes a system employing alternating currents of equal frequencies to be superimposed upon ordinary telegraph lines already operated by the present Morse systems, for increasing the facilities of the wires for the transmision of messages. Ills. 1000 w. Elec Wld & Engr—Dec. 30, 1905. No. 74167.

The London-Glasgow Underground Telegraph System. Illustrates and describes the construction of the pipe line in the present number. 1100 w. Elec. Rev, Lond—Jan. 12, 1906. Serial. 1st part. No. 74512 A.

DISTRIBUTION.

Accumulators.

See Electrical Engineering, Electrochemistry

Conductors.

The Choice of an Insulated Cable. Wallace S. Clark. Discusses points of value in the selection of the most economical types. 4400 w. Cent Sta—Jan, 1906. No. 74280.

New Jersey.

Power Generation and Distribution on the System of the Public Service Corporation of New Jersey. The present number gives an illustrated description of the Marion (Hackensack River) station. 2000 w. St Ry Jour—Jan. 6, 1906. Serial. 1st part. No. 74226 C.

The Electrical Distribution System of the Public Service Corporation of New Jersey. G. U. G. Holman. The present number is principally a review of the history of this organization, and an account of the distribution problem. 2500 w. Elec Wld—Jan. 13, 1906. Serial. 1st part. No. 74436.

Underground Mains.

The Maintenance of Underground Mains. George L. Black. Abstract of a paper read before the Glasgow Sec. of the Inst. of Elec Engrs. A practical paper containing many useful hints. 3500 w. Elect'n, Lond—Jan. 12, 1906. No. 74517 A.

Wiring.

Exposed Circuit Wiring. Louis J. Auerbacher. An illustrated article giving directions for the proper execution of the work, and information in regard to materials. 1600 w. Elec. Wld—Jan, 1906. No. 74312.

ELECTRO-CHEMISTRY.

Accumulators.

Secondary Cells: Their Deterioration and the Causes. G. D. Aspinall Parr. Abstract of a paper read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Considers impurities present in cells in small quantities are the chief cause of unsatisfactory working and deterioration, and reports experiments designed to support the statement. 2000 w. Elect'n, Lond—Dec. 29, 1905. No. 74292 A.

Storage Batteries and Their Application to Public Institutions. Frank Crawter. Abstract of a paper read before the Engrs.-in-Charge. Discusses methods of charging, and the changes that take place during the phenomena of charge and discharge, and various practices and their effects. Elect'n, Lond—Jan. 12, 1906. No. 74519 A.

Electrolysis.

Electrolysis by Alternating currents. Reviews some researches in this field, commenting on the results. 1500 w. Am Gas Lgt Jour—Jan. 22, 1906. No. 74481.

Galvanizing.

Electrolytical Galvanizing. Henry I. White. Report of mechanical and chemical tests in proof that steel and iron articles coated by the Electrolytical process are superior to those galvanized by the hot process in their resistance to both mechanical and atmospheric action. 1800 w. Ir Age—Jan. 18, 1906. No. 74433.

Hypochlorites.

The Production of a Disinfectant (Hypochlorite of Sodium) by Electrolysis. C. V. Biggs. Discusses the possibility of rendering the process a commercially successful one. 800 w. Elec Engr, Lond—Dec. 22, 1905. No. 74141 A.

Iron.

The Electrometallurgy of Iron and the Iron Alloys (Electrometallurgie des Eisens und der Eisenlegierungen). J. Hess. A review of the practical methods of smelting iron and refining steel by electrical processes. Serial. Part I. Zeitschr f Elektrochemie—Jan 12, 1906. No. 74663 G.

Nitrogen.

The Fixation of Atmospheric Nitrogen. Editorial discussing the importance of nitrogen in the household of nature; its chief sources, and what has been accomplished in utilizing the stores of the atmosphere. 3800 w. Engng—Jan. 19, 1906. No. 74750 A.

Ozone.

Recent Devices for the Production of Ozone (Neue Apparate zur Erzeugung von Ozon). Dr. Kausch. A general review of recent patents, with especial reference to water purification. Serial. Part I. 800 w. Elektrochemische Zeitschr—Dec., 1905. No. 74664 G.

Refining.

Electro-Chemical Refining of Copper. Birger Carlson. Translation of an important paper by a Swedish metallurgist, giving an impartial comparison of the multiple system and the series system in the electrolytic refining of copper, as carried on in the United States. 3500 w. Min Jour—Jan. 20, 1906. No. 74742 A.

Electro-Technical Industries. George E. Walsh. Calls attention to the effect of electrometallurgy on the manufacture and refining of articles of commerce, copper refining, artificial graphite, and the use of the electric furnace in various industries, etc. 1800 w. Sci Am—Jan. 20, 1906. No. 74438.

Review.

Electrochemistry and Electrometallurgy in 1905. Charles F. Burgess. Reviews the standing of the industries, the new products, the value of the electric furnace, etc. 2500 w. Elec Rev, N. Y.—Jan. 13, 1906. No. 74431.

Smelting.

Preliminary Report on the Smelting of Magnetic Iron Ore by Electricity. Preliminary report submitted by Dr. David, T. Day on the subject of smelting by electricity the magnetic iron ores obtained from various points on the Pacific beach. 1200 w. Min Rept—Dec. 28, 1905. No. 74111.

ELECTRO-PHYSICS.

Conductivity.

On the Electric Conductivity of a Vacuum. J. A. Fleming in *Technics*. An account of experimental investigations showing that certain conditions change the results, and giving facts explaining the phenomena, and a general study of the subject. 4000 w. Sci Am Sup—Jan. 20, 1906. No. 74444.

Discharges.

High-Potential Discharges. A. Frederick Collins. A review of disruptive discharges in their application to wireless telegraphy, and connective discharges in their relation to the human body. Ills. 1500 w. Sci. Am—Jan. 27, 1906. No. 74571.

The Electric Spark. Dr. G. A. Hemsalech in the *La Science au XXme Siècle*. An illustrated article considering only sparks produced by the discharge of condensers through air at ordinary atmospheric pressure. 5000 w. Sci Am Sup—Jan. 27, 1906. No. 74575.

Oscillations.

Phase-Shifted High-Frequency Oscillations. Prof. Ferdinand Braun. Gives abstract translation of an article on phase-displacement measuring, published in

Physikalische Zeitschrift. Considers phase displacement by ohmic resistance, and by resonance. Ills. 4000 w. Elect'n, Lond—Jan. 19, 1906. No. 74740 A.

Radioactivity.

The Heating Effects Produced by Röntgen Rays in Different Metals, and Their Relation to the Question of Changes in the Atom. H. A. Bumstead. An account of experimental investigations, describing the apparatus used and giving results and conclusions. 7500 w. Am Jour of Sci—Jan, 1906. No. 74178 D.

The Present Position of Radioactivity. Frederick Soddy. Abstract of presidential address to the Röntgen Society. 5500 w. Elect'n, Lond—Jan. 5, 1906. No. 74408 A. A.

Resistance.

Brush-Contact Resistance. K. C. Nandi. An account of some experiments made at the Glasgow University. 600 w. Elec Engr, Lond—Jan. 5, 1906. No. 74403 A.

GENERATING STATIONS.

Accumulators.

See Electrical Engineering, Electro-chemistry.

Alternators.

A Note on the Calculation of the Armature Reaction of Alternators. Waldo V. Lyon. A discussion showing the assumptions that must be made to calculate the armature reaction as it is ordinarily done. Considers first a single-phase alternator, and then a three-phase machine. 3000 w. Tech Qr—Dec., 1905. No. 74588 E.

A Self-Exciting Alternator. E. F. Alexanderson. Illustrated description of an electric generator with rectifying commutator and automatic voltage regulation by three-phase field rheostat. 3500 w. Pro Am Inst of Elec Engrs—Jan., 1906. No. 74762 D.

The Wiring and Connection of Alternators. G. A. Burnham. An illustrated explanation of the three classes of alternators; the revolving armature, the revolving field, and the inductor type. 1600 w. Engr, U S A—Jan. 15, 1906. No. 74478 C.

Armature Windings.

Winding of Direct-Current Armatures. A. C. Jordan. An illustrated detailed description of the 101 B armature, with especial reference to the points of difference between this and the 38 B type. Type S armatures are also described, with general considerations of armature windings. 2000 w. Elec Jour—Jan, 1906. No. 74538.

Booster.

A Reversible Booster and Its Running. C. Turnbull. Read before the Newcastle Local Sec. of the Inst. of Elec. Engrs. An illustrated description of the Lancashire booster, its working and all matters relating to its application. 6000 w. Elec Engr, Lond—Jan. 19, 1906. No. 74736 A.

Brushes.

Brush Holders. Bernhard Zingelmann. Remarks on recent devices and improvements, and the requirements of a good brush-holder. 1800 w. Elec Rev, Lond—Jan. 12, 1906. No. 74513 A.

Chicago.

Power Plant of the Chicago Drainage Canal. An illustrated article dealing principally with the power-house and its equipment. 3900 w. Eng News—Jan. 18, 1906. No. 74457.

Combined Plant.

An Ice-Making Electric Light Station in Florida. James F. Hobart. Describes the plant of the Plant City Electric and Refrigerating Company and its operation. Ills. 1400 w. Elec Wld—Jan. 13, 1906. No. 74437.

Commercial Problems.

Commercial and Engineering Tendencies Affecting Central Stations. J. H. Hallberg. A review of recent developments in power stations, distribution, lighting and other service. 3000 w. Elec Rev, N. Y.—Jan. 13, 1906. No. 74430.

Costs.

Cost of Generating Electric Power. F. A. Giffin. Gives formulæ and figures intended to be applicable to a modern, power-station containing four 1000-kw. units, and assumptions are made regarding the manner in which the efficiency of each piece of apparatus varies with the load. 2000 w. St. Ry Jour—Dec. 30, 1905. No. 74122 C.

Dynamos.

Auxiliary Reversing Poles for Large Continuous-Current Dynamos. H. M. Hobart. On the use of auxiliary reversing poles for direct-current, turbine driven generators. Shows how this pole can be applied to a 750-kw., 250-volt generator driven at 1500 revolutions, showing the considerations entering into the design. Ills. 3500 w. Elec Rev, N. Y.—Jan. 20, 1906. No. 74468.

Efficiency.

Power Plant Economics. Henry G. Stott. An analysis of the losses in the conversion of coal into electric current, and discussion of means for diminishing them, with account of the latest practice in prime movers and other electric station features. Diagrams and tables. 5000 w. Pro Am Inst of Elec Engrs—Jan, 1906. No. 74761 D.

Hydro-Electric.

Additional Power Development at Sewalls Falls, N. H. Edw. B. Richardson.

Illustrated detailed description of a new power station on the Merrimac River, in which vertical direct-connected units were installed. 5000 w. Eng Rec—Jan. 6, 1906. No. 74277.

A High Head Water Power Electric Plant on the Animas River, Colo. George M. Peek. Illustrates and describes a plant employing a static head of nearly 1000 ft. and generating electric current at 50,000 volts pressure for transmission to the important mining camps of Durango and Silverton, 25 miles distant. 1500 w. Eng News, Jan. 4, 1906. No. 74168.

Hydro-Electric Lighting and Power Plant at Harrisonburg, Virginia. F. F. Coleman. Illustrates and describes a plant on the Shenandoah River which is an example of the possibilities in the development of numerous single waterfalls. 200 w. Elec Wld & Engr—Dec. 30, 1905. No. 74165.

Jhelum River Hydroelectric Power Installation in British India. Gives a description of the water-wheels and generator connections. 1600 w. Elec Rev, N. Y.—Jan. 6, 1906. No. 74234.

The Hydraulic Accumulator Station at Ruppoldingen, Switzerland, (Die Akkumulierungsanlage in Ruppoldingen, in der Schweiz). S. Herzog. Power is stored hydraulically to aid in overcoming the peak of the load on the dynamos. Two articles, 4000 w. Zeitschr f Elektrotechnik —Dec. 17, 24, 1905. No. 74657 each D.

The Hydro-Electric Power Station of the City of Preran, Moravia (Hydroelektrische Kraftzentrale der Stadt Preran). A. Martinek. Plans of the buildings and details of the turbines. 1500 w. Elektrotech u Maschinenbau—Jan. 1, 1906. No. 74659 D.

The Jhelum River Power Plant. Illustrated account of this installation in British India, describing the country and also the plant. 4500 w. Jour of Elec—Jan., 1906. No 74307 C

The Mazarin Hydro-Electric Station (Installation Hydro-Electrique de l'Usine Mazarin). Ch. Dantin. An illustrated description of the hydraulic plant at Mézieres in the North of France, utilizing the power of the Meuse and delivering it to the Clément automobile works. 2000 w. 1 plate. Génie Civil—Dec. 16, 1905. No. 74622 D.

The Montbovon Hydro-Electric Station (L'Usine de Montbovon). D. Gauchat. Describing the plant utilizing the power of the Sarine above the lake of Geneva, Switzerland. 1800 w. Bull Tech de la Suisse Rom—Jan. 10, 1906. No. 74668 D.

The Plant of the Vancouver Power Company (Ltd.). Wynn Meredith. Illustrated detailed description of this interesting plant on the Pacific Coast, the power of a glacial lake being utilized. 5800 w. Jour of Elec—Jan., 1906. Serial. 1st part. No. 74306 C.

Management.

Central Station Economics in Massachusetts. A study of two typical medium-sized companies. The Salem Electric Lighting Co. and the Haverhill Electric Co. are considered. 2800 w. Elec Wld—Jan., 1906. No. 74314.

The Management of Small Central Stations. Henry Joseph. Discusses day loads and the necessity of keeping capital costs as low as possible on small systems. Meters and the prepayment system are also considered. 2800 w. Elec Rev, Lond —Dec. 29, 1905. No. 74290 A.

Marion.

The Marion (Hackensack River) Station of the Public Service Corporation of New Jersey. Illustrated detailed description of this station and its equipment. 2000 w. Elec Wld—Jan., 1906. No. 74309.

Relay.

The Overload and Reverse Current Relay. An illustrated description of an automatic device in which an increase in current starts a motor which operates a circuit breaker. 3000 w. Elec Rev, Lond—Dec. 29, 1905. Serial, 1st part. No. 74-291 A.

Rural Service.

District Supply in Rural Communities. Gives accounts of plants successfully operating a district supply service of electric light and power, with general remarks. 3500 w. Elec Wld—Jan., 1906. No. 74313.

Supervision.

Official Supervision of Electric Plants (Die Beabsichtige Staatliche Ueberwachung Elektrischer Anlangen). H. Passavant. A discusssion of the proposed government supervision of electric stations, showing that many other departments of industry are far more dangerous. 6000 w. Elektrotech Zeitschr—Dec. 28, 1905. No. 74656 B.

Switch Gear.

Notes on Heavy Electric Switch Gear. J. Whitcher. Abstract of a paper read before the Rugby Engng. Society. Considers types of switches and circuit breakers. Short discussion. 2500 w. Elect'n, Lond—Jan. 5, 1906. No. 74407 A.

The Ferranti-Field Three-Phase Switch. Illustrated description of one of the most recent designs of a large three-phase oil switch and its working. 1500 w. Engng —Jan. 5. 1906. No. 74418 A.

Switzerland.

Swiss Electrolytic Plants. C. L. Durand. Brief illustrated description of features of the plants at La Praz and at Cheddes. 1500 w. Elec Rev, N Y—Jan. 6, 1906. No. 74233.

Turbo-Alternators.

Design of Turbo-Alternators. H. S. Meyer. Gives complete technical data of the 2,000 kw. turbo-alternators recently built for Yorkshire and Lancashire Power Co. Ills. 3800 w. Elect'n, Lond—Jan. 12, 1906. No. 74516 A.

LIGHTING.

Factories.

Factory Lighting. E. Leavenworth Elliott. Suggestions for the successful illumination of various factories by electricity. 2500 w. Cent Sta—Jan., 1906. No. 74279.

Interiors.

The Lighting of Living Rooms and Parlors. J. R. Cravath and V. R. Lansingh. An illustrated article considering examples of good and bad lighting, and discussing the essentials of satisfactory arrangements. 3500 w. Elec Wld—Jan., 1906. No. 74311.

MEASUREMENT.

High Frequency.

The Measurement of High Frequency Currents and Electric Waves. Prof. J. A. Fleming. Cantor lectures. Explains the methods of measurement used in the writer's investigations, illustrating instruments. 5000 w. Jour Soc of Arts—Dec. 29, 1905. Serial. 1st part. No. 74282 A.

Induction.

A Method for the Measurement of Self-Induction. Ernest Wilson and W. H. Wilson. Describes a method found convenient in practice. 900 w. Elect'n, Lond Jan. 5, 1906. No. 74405 A.

Meters.

Two New Electrolytic Meters. S. H. Holden. Illustrates and describes two new electrolytic meters, both of which belong to the gas voltometer type, one belonging to the shunted and the other the unshunted class. Short discussion. 3500 w. Elect'n, Lond—Dec. 22, 1905. No. 74144 A.

Standards.

The National Bureau of Standards. S. W. Stratton and E. B. Rosa. Illustrated detailed description of the buildings and equipment and the methods of carrying out the work. 13000 w. Am Inst of Elec Engrs—Dec., 1905. No. 74181 D.

Testing.

A Testing Laboratory in Practical Operation. Clayton H. Sharp. An account of the results attained in the establishment and maintenance of a laboratory for commercial electrical testing. 2800 w. Am Inst of Elec Engrs—Dec., 1905 No. 74182 D.

The Electrical Equipment of a D. C. Test Room for an Electricity Supply Undertaking. A. C. Johnson. Illustrates and describes the test room equipment at Burnley, England. 1700 w. Elec Rev, Lond—Jan. 19, 1906. No. 74739 A.

MOTORS.

Alternating.

Electric Traction by Alternating-Current Motors. Dr. Louis Bell. Comparing the alternating and the continuous-current motors, with especial reference to electric traction on main line railroads. 3000 w. Eng Mag—Feb., 1906. No. 74671 B.

Continuous Current.

The Use of Shunt, Compound, and Series-Wound Motors. F. W. Holbrook. Aims to give a clear understanding of the fitness and unfitness of the various types of windings with respect to the duty to be performed. 3000 w. Engr. U. S. A.—Jan. 15, 1906. No. 74479 C.

Control.

Automatic Control for Large Direct-Current Motors. H. D. James. An illustrated description of a controller capable of handling a motor of 900 h. p. and its behavior under test. 1200 w. Elec Jour—Jan., 1906. No. 74537.

Methods of "Changing Speed" in Electric Motor Driving. E. Kilburn Scott. An illustrated discussion of the methods in use, both mechanical and electrical. 2000 w. Ir & Coal Trds Rev—Jan. 12, 1906. No. 74530 A.

Induction Motors.

Locating Faults in Induction Motors. E. B. Raymond. Calls attention to certain characteristics of the induction motor, and discusses troubles that sometimes prove annoying and puzzling. 1800 w. Engr. U S A—Jan. 15, 1906. No. 74477 C.

Single Phase.

Alternating-Current Commutator Motors. (Wechselstrom-Kommutator motoren). F. Niethammer. A mathematical examination of the various types of single-phase commutator motors, with diagrams showing sparking pressures and operative relations. Two articles. 3000 w. Elektrotech u Maschinenbau—Jan. 1, 7, 1906. No. 74658 each D.

A Study of a Single-Phase Series Motor. George I. Rhodes. Illustrated report of test made. 2000 w. Tech Qr—Dec., 1905. No. 74587 E.

Notes on the Application of the Single-Phase Motor for Traction Service (Beitrag zum Entwurf von Einphasenserienmotoren für Bahnzwecke). Emil Dick. A comparison of the advantages of the single-phase alternating motor with the continuous current motor for railways. Serial. Part I. 2500 w. Elektrotech u Maschinenbau—Jan. 7, 1906. No. 74662 D.

See also Street and Electric Railways.

TRANSMISSION.

Direct Current.

Long Distance Power Transmisssion by Direct Current. Frank J. Sprague. Discussses the economic side of direct-current transmission, referring to the Victoria Falls project. Also editorial. 3800 w. Elec Wld & Engr—Dec. 30, 1905. No. 74164.

High-Tension.

A Pertinacious Current; or the Storage of High-Tension Electricity by Means of Valves. Sir Oliver Lodge, before the Royal Inst. of Gt. Britain, explains this method of securing and maintaining a continuous high-tension current, and some uses to which it may be applied. 3500 w. Sci Am Sup—Jan. 13, 1906. No. 74390.

Electric Mains for Power Transmission Work. Prof. John T. Morris. Read before the Junior Inst. of Engrs. A brief account of some of the main considerations which affect high-tension transmission. Deals with the apparatus used for transmission of currents at voltages from 5000 to the maximum voltage used. 4500 w. Elec Engr, Lond—Dec. 29, 1905. Serial. 1st part. No. 74287 A.

Losses.

Economical Loss in Electric Transmission. G. R. Henderson. Discusses the cost of excess plant necesssary because of line losses. 1200 w. Am Engr & R R Jour—Jan., 1906. No. 74101 C.

Line Towers.

The Structural Design of Towers for Electric Power-Transmission Lines. Joseph Mayer. Discusses the forces acting on the towers through wind presssure, ice load, and longitudinal forces; the types of foundations, design, &c. Ills. 6500 w. Eng News—Jan. 4, 1906. No. 74169.

Progress.

Power Transmission in 1906. Dr. F. A. C. Perrine. Calls attention to the change of sentiment by financiers for water-power securities; and the problem of the lightning arrester, the insulator problem, &c. 1000 w. Elec Rev, N Y—Jan. 13, 1906. No. 74428.

Protective Devices.

Discussion on Lightning and Lightning Protective Apparatus. 6800 w. Am Inst of Elec Engrs—Dec., 1905. No. 74185 D.

Zambesi.

The Zambesi Power Scheme. W. B. Esson. A reply to criticisms, concluding that the undertaking is economically sound providing no difficulties prevent the fulfillment of proposed conditions. 2500 w. Elec Rev, Lond—Jan. 12, 1906. No. 74514 A.

MISCELLANY.

Efficiencies.

Efficiencies. James Swinburne. Abstract of an address to the students of the Manchester local section of the Inst. of Elec. Engrs. 3500 w. Elec Rev, N Y—Dec. 30, 1905. No. 74106.

Electrical Problems.

Unsolved Problems in Electrical Engineering. Col. Rookes Evelyn Bell Crompton. The "James Forrest" lecture, 1905. Treats a few of these problems, referring to some very near solution, and others that will greatly benefit mankind. 11000 w. Inst of Civ Engrs—April 10, 1905. No. 74354 N.

Review.

Electrical Development in Europe in 1905. C. L. Durand. A review of progress in the various electrical industries. 2000 w. Elec Rev, N Y—Jan. 13, 1906. No. 74432.

INDUSTRIAL ECONOMY

Accounting.

Cold Storage Accounting. Lamont Brace. Helpful suggestions. 1600 w. Ice & Refrig—Jan., 1906. Serial. 1st part. No. 74281 C.

China.

Anti-Foreign Agitation in China. Editorial discussion of the boycott of American goods and other matters affecting Chinese trade. 2700 w. Eng'ng—Dec. 22, 1905. No. 74153 A.

Chinese Miners.

Chinese Coolies in the Transvaal. Describes the conditions under which 45,000 Chinese coolies have been collected in China and sent to South Africa to serve as workmen in the mines. Shows the contract has been carried out in an honest manner to the advantage of all concerned. 1700 w. Eng & Min Jour—Jan. 20, 1906. No. 74473.

Coal Trade.

The Coal Trade in 1905. Editorial review of the trade of the year in Great Britain. 2000 w. Col Guard—Jan. 5, 1906. No. 74412 A.

Copper Trade.

Annual Review of the American Copper

Trade. Horace J. Stevens. Brief review of this industry in the United States, from its earliest origin, with particulars of the production during 1905. 4000 w. Min Wld—Jan. 6, 1906. No. 74232.

Annual Review of the World's Copper Trade. Horace J. Stevens. Reports the largest yearly production ever known, with much interesting information. 3500 w. Min Wld—Jan. 13, 1906. No. 74370.

Costs.

The Estimation of Costs. A. W. Farnsworth. Read before the Coventry Engng. Soc. Discusses methods of estimating, the essentials of accuracy, considering briefly how an estimate should be made. 4500 w. Engr, Lond—Jan. 19, 1906. No. 74758 A.

Education.

Is Amalgamation a Failure? L. H. Chandler. A very full exposition of the engineering training given at the Naval Academy in Annapolis. Ills. 3600 w. Pro U S Naval Inst—Dec., 1905. No. 74717 G.

Engineering Trade.

Industrial Depressions and Engineering Export and Import Trade. W. Pollard Digby. A critical statistical analysis of the sources of national prosperity and their relation to commercial fluctuations. 3500 w. Engineering Magazine—Feb., 1906. No. 74674 B.

Export Duty.

The Economic Effect of the Export Duty on Coal. Emerson Bainbridge. Aims to prove that the imposition of this tax in England has been and is a serious economic error. 3000 w. Col Guard—Jan. 5, 1906. No. 74413 A.

Germany.

The American and the German Peril. Louis J. Magee. Mr. Magee's second article deals principally with the present German industrial policy and its ideals. 4000 w. Engineering Magazine—Feb., 1906. No. 74670 B.

Iron Trade.

The Chicago Iron Trade in 1905. A. O. Backert. Reports the projected increase in producing capacity, an unequaled buying movement, new construction materials, finished product, &c. 5000 w. Ir Age—Jan. 4, 1906. No. 74224.

The Philadelphia Iron Trade in 1905. Thomas Hobson. Gives a cheerful forecast for 1906, considering prices, materials, &c. 4000 w. Ir Age—Jan. 4, 1906. No. 74225.

The Pittsburg Iron Trade in 1905. Robert A. Walker. A review of the year, reporting new construction, price agreements, labor matters, materials, coke, and finished iron and steel. 6400 w. Ir Age—Jan. 4, 1906. No. 74223.

Labor.

Better Methods of Compensation for Workmen. George W. Dickie. Discusses present systems and their disadvantages, and outlines a system of contracting for the labor as a whole with the workmen, urging its advantages. 6000 w. Cassier's Mag—Jan., 1906. No. 74460 B.

Dr. Wm. Jacks on Labor Problems and Legislation. Interesting remarks on the problems of trade disputes and industrial coöperation. 2300 w. Ir & Coal Trds Rev—Jan. 19, 1906. No. 74760 A.

Mining Industry.

I. Copper. Frederick Hobart. II. Copper in Arizona in 1905. James Douglas. III. The Lake Superior Copper District. C. E. Thomas. The papers reviewing the history of copper for the year, the production prices, &c. 6800 w. Eng & Min Jour—Jan. 6, 1906. No. 74253.

I. Gold and Silver. Frederick Hobart. II. Commercial Movement of Gold and Silver in 1905. A. Selwyn-Brown. Yearly reports of production and demand. 2500 w. Eng & Min Jour—Jan. 6, 1906. No. 74252.

Iron and Steel. Reports concerning this industry from Frederick Hobart. L. W. Friedman, E. Morrrison, George H. Cushing, E. F. Luty and Dwight E. Woodbridge, covering the various districts. 1400 w. Eng & Min Jour—Jan. 6, 1906. No. 74271.

I. Lead. W. R. Ingalls. II. The Coeur D'Alene in 1905. Stanley A. Easton. III. The Southeast Missouri Lead District. H. A. Wheeler. A review of the year. 4500 w. Eng & Min Jour—Jan 6, 1906. No. 74254.

Ore Deposits and Industrial Supremacy. John L. Steward. Considers the influence of economic geology on the industrial stability of the country. 2800 w. Ec Geol—Dec., 1905. No. 74707 D.

I. Zinc. W. R. Ingalls. II. The Joplin District. Jesse A. Zook. III. Virginia Lead and Zinc Mining in 1905. J. A. Van Mater. IV. Zinc Mining in Wisconsin in 1905. E. W. Moore. A yearly review of the zinc industry in the various districts. 6400 w. Eng & Min Jour—Jan. 6. 1906. No. 74255.

Patents.

Patents in Their Relation to the Gas Engine and the Automobile. S. M. Howell. The writer has given much time to the study of the priority of patents of this class, and aims to give some helpful information on this subject. Ills. 2200 w. Mach. N Y—Jan., 1906. Serial. 1st part. No. 74115 C.

Pig Iron.

The Southern Pig Iron Market in 1905. James A. Green. A review of the year by months. 4500 w. Ir Age—Jan. 11, 1906. No. 74303.

Selling.

How Machine Tools Are Sold. A conversation between Mr. H. F. Frevert, who has had many years' experience of trade conditions on both sides of the Atlantic, and the publisher. 4400 w. Mach, N Y—Jan., 1906. No. 74116 C.

Shop Hygiene.

Recent Improvements in the Hygiene of Workshops (Les Améliorations Récentes dans l'Hygiène des Ateliers). Paul Razous. Discussing especially appliances for the removal of dust, gases, and injurious vapors from workrooms. Two articles. 5000 w. Génie Civil—Jan. 6, 13, 1906. No. 74633 each D.

Tin Plate.

The Sheet and Tin Plate Trade. B. E. Luty. A review of the phenomenal increase in production, comparing with the previous year, and discussing prices, labor, competition, &c. 3500 w. Ir Age—Jan. 11, 1906. No. 74302.

Transportation Costs.

The Cost of Transportation of the Raw Materials in the Iron Industry (Die Rohstoff-Gütertarife der Eisenindustrie). E. Schrödter. A comparative review of the cost of railway transport of iron ore in the principal manufacturing countries, showing the importance of a reduction in rates in Germany. 10000 w. Stahl u Eisen—Dec. 15, 1905. No. 74642 D.

Works Management.

The Square Deal in Works Management. O. M. Becker. Mr. Becker's second paper discussses the methods which may be employed in the betterment of the plant itself, with numerous illustrations. 5000 w. Engineering Magazine—Feb., 1906. No. 74672 B.

Zinc.

The Zinc Industry in Silesia in 1905. Paul Speier. Reviews the business of the year, and calls attention to the change in zinc smelting practice gradually taking place, from the old type of furnace to the Rhenish type. Also editorial. 2000 w. Eng & Min Jour—Jan. 27, 1906. No. 74730.

MARINE AND NAVAL ENGINEERING

Barges.

Steel Barges. Richard J. Donovan. Gives statements concerning river transportation, the character of the business and methods of handling, the types of carriers, &c., illustrating and describing the typical river steamboat and steel barge. Discussion. 4000 w. Pro Engrs' Soc of W Penn—Jan., 1906. No. 74542 D.

Coaling.

Floating Depot for Coaling Warships. Day Allen Willey. Illlustrates and describes the floating depot placed in service by the British Admiralty, and the methods used for loading and unloading. 800 w. Sci Am—Jan. 20, 1906. No. 74439.

Docks.

A New Graving Dock at Nagasaki, Japan. Continued discussion of the paper by Naoji Sheraishi. 3000 w. Pro Am Soc of Civ Engrs—Jan., 1906. No. 74703 E.

The Cavité Drydock. Day Allen Willey. An illustrated article giving report of tests made and the arrangements for towing the structure to the Philippines. 1600 w. Sci Am—Jan. 6, 1906. No. 74195.

Liner.

Cunard Turbine Liner Carmania. Illustrated detailed description of this large turbine steamer, its equipment, and report of trials. 8200 w. Marine Rev—Jan. 4, 1906. No. 74238.

Marine Registry.

Bureaus for the Classification of Ships (Les Offices de Classification de Navires). An account of the origin and operations of the Bureau Veritas and of Lloyds, in the classification and registry of vessels. 3000 w. Génie Civil—Dec. 30, 1905. No. 74631 D.

Merchant Marine.

The Merchant Marine as an Auxiliary to the Navy. Report of Admiral George Dewey, President-General Board, Navy Department, to the Secretary of the Navy. 2000 w. Naut Gaz—Dec. 28, 1905. No. 74110.

Upbuilding of Our Merchant Marine. F. W. Hibbs. Urging the establishing of the American merchant marine on an equal footing with other nations. 3800 w. Marine Rev—Dec. 28, 1905. No. 74096.

Motor Boats.

Review of the 1905 Autoboat Season. W. P. Stephens. A review of the races, regattas, carnivals, &c. 3000 w. Automobile—Jan. 11, 1906. No. 74361.

Propulsion.

The "Motogodille," a Motor Device for Propelling Small Boats. Illustrated description of an inexpensive and simple method of applying a small gasoline motor to boats. 500 w. Sci Am Sup—Jan. 27, 1906. No. 74574.

Scouts.

H. M. S. Attentive. Illustration, description, and report of trial. 700 w. Engr, Lond—Dec. 22, 1905. No. 74157 A.

Scout Vessels for the United States Navy. Lieut. H. C. Dinger. Discusses the speed, endurance, and reliability of these vessels, their armament, habits, ability, structural strength, machinery, &c. 3800 w. Marine Rev—Jan. 11, 1906. No. 74343.

Shipbuilding.

A New and Interesting Overhead Traveling Gear for Expediting Construction in Shipyards. Illustrates and describes a new system recently erected in a British yard, which is able to serve every part of the berth. 1000 w. Sci Am—Jan. 27, 1906. No. 74570.

A Shipbuilding Cableway. Illustrated detailed description of an ingenious application of the cableway to the building of ships, in use at Jarrow-on-Tyne. 1500 w. Engr, Lond—Jan. 19, 1906. No. 74757 A.

Shipbuilding and Marine Engineering in 1905. A review of these industries in the United Kingdom. 4000 w. Engr—Jan. 5, 1906. Serial. 1st part. No. 74419 A.

Shipbuilding for the Navy. Lord Brassey. Discusses the naval requirements of Great Britain, favoring the building of smaller vessels, distributing the guns in more ships. Abstract of discussion. 20500 w. Inst of Civ Engrs (No. 3562). No. 74357 N.

Shipping.

The American Shipping Question. Col. Robert J. Lowry. A discussion of conditions in the past and present, and the action needed to restore American mercantile ships to the seas. 1800 w. Marine Rev—Jan. 18, 1906. No. 74467.

Signaling.

Submarine Signaling. Henry R. Gilson. Reviews the experimental investigations made during the last twenty years in this field, especially the success attained by American investigators, describing the present signaling system and explaining some of the uses to which it may be applied. Ills. 6500 w. Tech Qr—Dec., 1905. No. 74585 E.

Sounding.

A Long Wire Sweep for Soundings. D. B. Wainwright. Describes a sweep used in Frenchman's Bay, Me., and its operation. 1500 w. Eng Rec—Jan. 20, 1906. No. 74504.

Steamboat.

Magnificent Steamboat for Great Lakes. Illustrations and brief description of a 400-ft. passenger steamboat to be built for the Detroit and Cleveland Nav. Co. 700 w. Naut Gaz—Jan. 18, 1906. No. 74483.

Steamer.

The Steamer Hoover and Mason. Illustrated description of the new lake ore carrier having transverse hoppers. 1100 w. Ir Age—Jan. 4, 1906. No. 74216.

Submarines.

Submarines. J. H. Tomb. A brief description of types, operations of, and accidents to submarines. 2200 w. Pro U S Naval Inst—Dec., 1905. No. 74718 G.

Subsidies.

Shipping Subsidies. Royal Meeker. Abstract of an article in the *Pol. Sci. Qr.* A discussion of the subject of subsidies, concluding that there is no good economic reason for granting subsidies to the merchant marine either for construction or navigation. 3800 w. R R Gaz—Vol. XL, No. 3. No. 74456.

Torpedo.

The New Turbine Torpedo of the United States Navy. Illustrated description of the Bliss Leavitt Model. 1800 w. Sci Am—Jan. 6, 1906. No. 74194.

Torpedo Boats.

Torpedo Craft for Scouting Purposes. Reviews the performance of this class of vessels, and discusses their fighting value, their requirements under the changed conditions, and the possibility of combining the qualities of torpedo craft and scouting vessels. 1500 w. Engr, Lond—Jan. 5, 1906. No. 74425 A.

Turbine Steamer.

The Largest Turbine Steamship in the World. Archibald S. Hurd. A finely illustrated article giving a detailed description of the "Carmania" of the Cunard Line. 2000 w. Cassier's Mag—Jan., 1906. No. 74459 B.

The Trans-Atlantic Turbine Steamer Carmania (Der Trans-Atlantische Turbinendampfer Carmania). W. Kaemmerer. A general description of the propelling machinery, in comparison with that of the Caronia. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 6, 1906. No. 74607 D.

The Turbine Steamer Carmania (La Paquebot à Turbines Carmania.) L. Piaud. A fully illustrated general description of the new Cunard liner and her machinery. 2500 w. 1 plate. Génie Civil—Jan. 6, 1906. No. 74632 D.

Warships.

Warship Construction. A review of warship construction during 1905 in Great Britain. 3800 w. Engng—Dec. 29, 1905. No. 74297 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Ball-Bearings.

The Hoffman Ball-Bearings for Motor Cars. An illustrated article describing these bearings and the ball-bearing hub for cars of different types. 3000 w. Auto Jour—Jan. 13, 1906. Serial. 1st part. No. 74507 A.

Brakes.

Brakes of Various Types and Their Use. Maurice Pardet. Discusses various systems of braking in present use. 2000 w. Automobile—Jan. 4, 1906. No. 74205.

Methods in Brakes Seen at the Shows. Illustrated descriptions of interesting types. 1400 w. Automobile—Jan. 25, 1906. No. 74577.

Clutches.

Improved Transmissions and Clutches. Illustrates and describes interesting improvements noticed at the recent New York shows. 5000 w. Automobile—Jan. 25, 1906. No. 74576.

Commercial Vehicles.

The Fiat Commercial Vehicles. Illustrates and describes some details of these cars. 900 w. Auto Jour—Jan. 13, 1906. No. 74506 A.

Electric Vehicles.

Electromobiles. Henry F. Joel. A critical review of an article by Frank B. Rae on "Speed-time Curves for Automobile Motors," published in the *Electrical World and Engineer*. 1500 w. Elec Rev, Lond—Dec. 29, 1905. No. 74289 A.

Energy Consumed by Electric Automobiles. Alex. Churchward. Reports tests made with a special graphic recording meter designed by the General Electric Co. 900 w. Automobile—Jan. 11, 1906. No. 74360.

Engines.

Two-Cycle and Four-Cycle Engines. C. P. Malcolm. A discussion of the merits and demerits of the four-cycle and of the two-cycle engines. 3500 w. Automobile—Jan. 11, 1906. Serial. 1st part. No. 74358.

Exhibitions.

Cars and Airships at the Armory. An illustrated account of the opening of this show, describing some of the exhibits. 12500 w. Automobile—Jan. 15, 1906. No. 74450.

Garden Show a Beautiful Spectacle. An illustrated article describing some of the exhibits, their arrangement, and the scheme of decoration. 7800 w. Automobile—Jan. 18, 1906. No. 74449.

French Designs.

Comparative Analyses of French Design. W. F. Bradley. A comparative analysis of the 326 French cars shown at the Paris salon. 1000 w. Automobile—Jan. 11, 1906. No. 74359.

Motor Car Progress in France. The present article discusses the perturbed condition of the French industry and its causes, comparing English with French progress. 2000 w. Engr, Lond—Dec. 22, 1905. Serial. 1st part. No. 74156 A.

Ignition.

Ignition Practice at the Shows. An illustrated review of European and American practice as noticed at the recent exhibitions. 5500 w. Automobile—Jan. 25, 1906. No. 74578.

Lanchester.

The Twenty H. P. Four-Cylinder Lanchester. Illustrates and describes the engine, the countershaft, and the change speed mechanism. 1000 w. Autocar—Jan. 6, 1906. No. 74398 A.

Locomobile Models.

Locomobile Features of Construction. Illustrates and describes details of the two models for 1906. They are side-entrance touring cars, side-chain driven, with four-cylinder vertical water-cooled motors. 3000 w. Automobile—Jan. 4, 1906. No. 74206.

Magneto.

The Holley High-Tension Magneto. Illustrated description of a particularly interesting magneto. 1400 w. Automobile—Jan. 11, 1906. No. 74364.

Modern Cars.

"Small" and "Popular-Priced" Cars. Rene M. Petard. Begins an illustrated discussion of modern cars of the types named. 2200 w. Automobile—Jan. 15, 1906. Serial. 1st part. No. 74451.

Motor Cooling.

Motor Cooling Principles and Practices. L. M. Dieterich. An explanation of the characteristics of heat-conditions existing in an automobile gasoline motor, and the forms of cooling. 4400 w. Automobile—Jan. 11, 1906. No. 74363.

Napier.

The 1906 Six-Cylinder Napier Cars. An illustrated article giving detailed information concerning the construction of these cars. 1000 w. Auto Jour—Jan. 13, 1906. Serial. 1st part. No. 74505 A

1906 Models.

1906 Models at the Paris Salon Rene M. Petard. Begins an illustrated description of many of the new models shown. 1700 w. Automobile—Dec. 28, 1905. Serial. 1st part. No. 74204.

Omnibuses.

The Automobile Omnibuses of the General Omnibus Company of Paris. (Les Omnibus Automobiles de la Compagnie Générale des Omnibus à Paris). Col. G. Espitallier. A fully illustrated description of several types of omnibus under practical test in the public service in Paris. 3000 w. Génie Civil—Dec. 30, 1905. No. 74629 D.

Paris Exhibition.

Novelties at the Paris Automobile Show. Illustrated descriptions of cars, motor boat, and new searchlight. 2700 w. Sci Am Sup—Jan. 27, 1906. No. 74573.

Patents.

See Industrial Economy

Petrol-Electric.

The Auto-Mixte Petrol-Electric Car. Brief ilustrated description of the Auto-Mixte system, exhibited at the Paris Salon. 700 w. Auto Jour—Jan. 6, 1906. No. 74394 A.

Richard-Brasier.

The Richard-Brasier Cars of 1906. Illustrates and describes the new features introduced. 1000 w. Auto-car—Jan. 6, 1906. Serial. 1st part. No. 74396 A.

Talbot.

The 20 H. P. British Built Talbot Car. An illustrated article describing the engine, clutch, gear-box, etc. 1200 w. Autocar—Jan. 20, 1906. No. 74732 A.

Testing Plant.

Automobile Testing Plant at Purdue University. Brief illustrated description 500 w. R R Gaz—Vol. XL. No. 4. No. 74583.

Touring Cars.

Dorris Touring Car Makes Its Debut. An illustrated description of a modern touring type, having a 4-cylinder vertical water-cooled motor of 26-30 h. p., sliding gear transmission and shaft and bevel gear drive. 1200 w. Automobile—Jan. 11, 1906. No. 74362.

High-Powered American Touring Cars. Illustrates and describes numerous types. 6500 w. Sci Am—Jan. 13, 1906. No. 74392.

Trembler Coils.

Adjustment of Quick-Acting Trembler Coils. W. H. Glaser. An explanation of the mode of action and especially describing the easiest and best way of making the adjustment in practice. 1200 w. Autocar—Jan. 6, 1906. No. 74397 A.

COMBUSTION MOTORS.

Cylinder Cooling.

A Rational Method of Cooling Gas-Engine Cylinders. S. M. Howell. Shows the disadvantages of water cooling and describes a novel water-jacketed, high-pressure cylinder for a compound gas engine, stating the advantages claimed. 1800 w. Sci Am—Jan. 20, 1906. No. 74441.

Gas Cleaning.

Methods of Cleaning Furnace Gases (Ueber den Gegenwärtigen Stand der Gichtgasreinigung). F. J. Meyjes. Illustrating a number of recent devices for washing furnace discharge gases to remove the dust and clean it for use as fuel for gas engines. 2500 w. Stahl u Eisen—Jan. 1, 1906. No. 74647 D.

Gas Engines.

The Oechelhauser Gas-Engine. Illustrated detailed description of this large internal-combustion engine for utilizing the waste gases of blast furnaces and for working with producer gas. 2700 w. Engng—Jan. 5, 1906. Serial. 1st part. No. 74416 A.

Union Gas Engine of 250 Horse Power (Moteur à Gaz Union de 250 Chevaux). L. Ramakers. Illustrated description of horizontal double-acting gas engine, exhibited at Liége. 1000 w. 1 plate. Génie Civil—Dec. 30, 1905. No. 74630 D.

Gas Producer.

Gas Producer for Use with Mineral Oil (Gasogène pour Huiles Minérales). A description of the Lazareff gas producer for the direct conversion of heavy mineral oils into illuminating and fuel gas. 1200 w. Génie Civil—Dec. 16, 1905. No. 74625 D.

Gas Turbines.

The Question of the Gas Turbine. Robert M. Neilson. With commentary by Henry F. Schmidt. Discusses the probability of making the gas turbine a commercial success, and the difficulties of the problem. 2000 w. Power—Jan., 1906. No. 74127 C.

Patents.

See Industrial Economy.

Power Plants.

Modern Gas Engine Power Plants. Franz Koester. Gives illustrations of a number of large plants, with a brief review of the development of the gas engine. 1800 w. Eng Rec—Jan. 6, 1906. No. 74276.

Safety Factor.

The Choice of a Factor of Safety for a Machine Member. Forrest E. Cardullo. A discussion of the apparent factor of safety, and the factors which compose it, outlining the method of development, and illustrating by examples. 3300 w. Mach, N Y—Jan., 1906. No. 74114 C.

See also Mechanical Engineering, Automobiles.

HEATING AND COOLING.

Auditorium.

Heating and Ventilating the Main Auditorium of the Broadway Tabernacle, New York. C. Terau. Describes the conditions, and the installation of a blast system, with mechanical exhaust and automatic temperature control. 1600 w. Am Soc of Heat & Vent Engrs—Jan., 1906. No. 74337 C.

Drying.

Notes on Drying Plants (Einiges über Trockenanlagen). Karl Reyscher. A discussion of the best method of arranging the air circulation in the design of drying kilns. 3000 w. Zeitschr d Ver Deutscher Ing—Dec. 23, 1905. No. 74602 D.

Exhaust Steam.

Exhaust Steam for Heating Buildings. An illustrated discussion of systems which utilize steam for heating, the piping systems, &c. 2200 w. Engr, U S A —Jan. 1, 1906. Special No. No. 74324 D.

Franklin.

Benjamin Franklin, the First American Heating and Ventilating Engineer. Albert A. Cary. Address before the Am. Soc. of Heat. & Vent. Engrs. Considers Franklin's Pennsylvania fireplace, and his theory of heat, with his views concerning the prospects of obtaining coal for fuel in the United States. 3800 w. Eng Rec —Jan. 27, 1906. No. 74767.

Heat Insulation.

Heat Insulation; Its Principles as Related to Cold Storage Practice. J. B. d'Homergue. Treats of insulation as bearing directly on artificial refrigeration, the materials used; with report of tests carried out at Purdue University, the apparatus and methods employed, &c. Discussion. Ills. 9000 w. Pro Engrs' Soc of W Penn—Jan., 1906. No. 74543 D.

Hospital Heating.

Heating and Ventilation of St. Paul's Hospital, Montreal, Que. Alan G. McAvity. Describes the system installed, outlining the ideal aimed at, and discussing the efficiency of the installation. Ills. 3000 w. Can Soc of Civ Engrs—Jan. 18, 1906. No. 74763 D.

Hotel Plant.

Some Features of the Heating and Ventilating System of the Bellevue-Stratford Hotel, Philadelphia. William G. Snow. Exhaust steam is used for heating. The distributing system is described, and other features of interest. 3500 w. Am Soc of Heat & Vent Engrs—Jan., 1906. No. 74339 C.

Refrigeration.

Needed Improvements in the Transportation of Perishable Fruits: A Refrigeration Problem. Extracts from a paper by G. H. Powell. Discusses the difficulties of distribution in the fruit trade. 1600 w. Eng News—Jan. 4, 1906. No. 74176.

Return Pipes.

Sizes of Return Pipes in Steam Heating Apparatus. Jas. A. Donnelly. Considers the functions of return pipes and methods of proportioning. 3000 w. Am Soc of Heat & Vent Engrs—Jan., 1906. No. 74334 C.

Schoolhouses.

Schoolhouse Warming and Ventilation. Charles L. Hubbard. An actual installation of an indirect gravity steam heating system is discussed and illustrated. 2000 w. Met Work—Jan. 6, 1906. Serial. 1st part. No. 74186.

Warming and Ventilating a Schoolhouse at Pelham, N. Y. C. T. Richards. Illustrated description of a gravity system of furnace heating in a four-room building. 1700 w. Met Work—Jan. 13, 1906. No. 74328.

Steam Heating.

A New Vapor-Vacuum System of Steam Heating. Jas. A. Donnelly. Illustrated description of a system designed to work under the same principles as those governing mechanical circulations, where a vacuum pump is usually used upon the main return. 1000 w. Am Soc of Heat & Vent Engrs—Jan., 1906. No. 74336 C.

Heating with Ventilation. Discusses systems of heating where ventilation is also required, and methods of determining the sizes of pipes, amount of air, and other requirements. Ills. 2000 w. Special No. Engr, U S A—Jan. 1, 1906. No. 74325 D.

Ventilation.

Arrangements for the Ventilation of the Debating-Rooms of the New Riksdag's Building in Stockholm, and the Results Obtained in this Respect. William Dahlgren. Discusses whether upward or downward ventilation is more satisfactory. Both were tried and the upward system retained. Ills. 2800 w. Am Soc of Heat & Vent Engrs—Jan., 1906. No. 74335 C.

HYDRAULICS.

Centrifugal Pumps.

Test of a Three-Stage, Direct-Connected, Centrifugal Pumping Unit. Philip E. Harroun. Notes illustrating test, presented to draw out a general discussion at next meeting. Also short discussion. Ills. 4000 w. Pro Am Soc of Civ Engrs—Dec., 1905. No. 74094 E.

The Latest Developments of the Rateau High-Pressure Centrifugal Pump (Die Neuesten Ausführungstypen der Hochdruck Kreiselpumpe System Rateau). Julius Divis. Data concerning recent performances of multiple centrifugal pumps. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 16, 1905. No. 74650 D.

Flow.

Researches for the Determination of a Formula for the Flow of Water over Natural River Beds (Versuch der Aufstellung einer Geschwindigkeitsformel für natürliche Flussbette). Maximilian Matakiewicz. Tables and diagrams for the determination of coefficients and exponents for use with the modified Chézy formula. 4000 w. Oesterr Monatschr f d Oeffent Baudienst—Dec. 23, 1905. No. 74667 D.

Hydro-Electric Stations.

See Electrical Engineering, Generating Stations.

Pumping Plant.

Electric Motor Centrifugal Pumping Plant for Draining the Torresdale Tunnel, Philadelphia. Illustrates and describes a simple and efficient pumping plant, comprising as its distinctive elements, two high speed DeLaval electric motor centrifugal pumps, which promises wide usefulness in shaft sinking operation. 1200 w. Eng News—Jan. 25, 1906. No. 74568.

Electric Pumping Plant at Consett Ironworks. An illustrated description of the scheme adopted, the pumps having a capacity of nearly 8,600,000 gallons of water pumped in twenty-four hours. 2500 w. Engr, Lond—Jan. 12, 1906. No. 74526 A.

Turbines.

German Turbines at Niagara (Deutsche Turbinen am Niagara). Albert Ungerer. With illustrations and descriptions of the Francis type of turbines built by Voith, of Heidenheim, Würtemberg, for the Hamilton, and the Ontario Power Companies at Niagara Falls. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 16, 1905. No. 74600 D.

Studies upon the Pressure on the Step Bearing of the Vertical Shaft of the Francis Turbine (Studien über den Druck auf den Spurzapfen der Francis Turbinen mit Lotrechter Wellen) Dr. Karl Kobes. A mathematical discussion of the action of weight and water pressure upon the pivot of the vertical shaft in turbines of the Francis type. Serial. Part I. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 12, 1906. No. 74641 D.

The Best Point for Pivoting Turbine Guide Buckets (Experimentelle Bestimmung des Günstigen Drehpunktes von Turbinendrehschaufeln) Dr. R. Camerer. Describing experiments to determine the action of the hydraulic forces on turbine guides to find the best position for pivoting with respect to ease of movement. 1500 w. Zeitschr d Ver Deutscher Ing—Jan. 13, 1906. No. 74611 D.

Waves.

The Theory of the Propagation of a Single Wave along a Horizontal Elastic Tube (Théorie de l'Onde Solitaire qui se Propage le Long d'un Tube Elastique Horizontal). A. Boulanger. A mathematical examination of the propagation of the impulse produced in a tube filled with liquid and suddenly compressed at one end. 1500 w. Comptes Rendus—Dec. 11, 1905. No. 74638 D.

See Civil Engineering, Water Supply.

MACHINE WORKS AND FOUNDRIES.

Appliances.

Two Novel Workshop Appliances. Illustrates and describes a modern hand-planing tool, and an adjustable die stock. 600 w. Mech Engr—Jan. 13, 1906. No. 74508 A.

Bessemer.

The Value of the Small Bessemer Plant in the Machine Works (Die Bedeutung der Kleinbessemerei für die Eisenhüttenindustrie und den Maschinenbau). Hans van Gendt. A discussion of the extent to which a small Bessemer converter may be economically employed in the ordinary foundry. 3000 w. Stahl u Eisen—Dec. 15, 1905. No. 74643 D.

Car Wheels.

Machine Molding and Continuous Casting of Car Wheels. Illustrated detailed description of the process as carried out at the plant of the American Car & Foundry Co., Terre Haute, Ind. 3000 w. Ir Age—Jan. 4, 1906. No. 74214.

Cast Iron.

Cast Iron in the Foundry. Percy Longmuir. Presents some aspects of foundry practice in the mixing, melting and molding of castings. Ills. 5000 w. Jour of W of Scotland Ir & St Inst—Dec., 1905. No. 74720 D.

Costs.

Foundry Costs. Ellsworth M. Taylor. Read at the A. F. A. convention. The importance of accurate cost methods are set forth, and an outline given, covering in a general way the vital points in regard to foundries. 3500 w. Foundry—Jan, 1906. No. 74557.

Crushing Mills.

Sugar-Cane Crushing Mill. An illustrated detailed description of a fine example of this class of machinery built for British Guiana. 2000 w. Engr, Lond—Jan. 12, 1906. No. 74527 A.

Drilling Machine.

Horizontal Drilling and Boring Machine. Illustrated description of a fine machine tool recently built in England. 700 w. Engr, Lond—Jan. 5, 1906. No. 74424 A.

Fan-Blowers.

The Conditions of Fan-Blower Design. Walter B. Snow. An explanation of the forces to be considered in the design of various types. 2500 w. Cassier's Mag—Jan., 1906. No. 74463 B.

Foundries.

Fireclays and Molding Sands. Percy Longmuir. Read before the British Found. Assn. Discusses the three classes of refractory materials, both furnace materials and molding sands. 4000 w. Ir & Coal Trds Rev—Jan. 12, 1906. No. 74529 A.

Heating and Ventilation of Foundries. Harry Malone. Briefly considers different systems of heating, with remarks on the difficulties peculiar to the work. 1000 w. Foundry—Jan, 1906. No. 74560.

The Foundry on a Chemical Basis. Reginald Meeks. Considers how to use a chemist to advantage, specifications for ordinary foundry iron, sampling, figuring the mixture, the chemists' report, steels, etc. 4000 w. Ir Age—Jan. 4, 1906. No. 74218.

Galvanizing.

Galvanizing. Dr. R. Moldenke. Gives an outline of the galvanizing process as now carried on. 1500 w. Foundry—Jan. 1906. No. 74558.

Indexing.

A Drawing Record and Indexing System. Brief description of records kept for machine tool repairs. 900 w. Am Mach—Vol. 29. No. 2. No. 74318.

Iron Works.

Some Notes on a Visit to Iron and Steel Works in the United States and Canada. P. N. Cunningham. Deals with the transportation, handling, and assembling of material in iron and steel works, and the accessories connected with such plants. Ills. Discussion. 10600 w. Jour of W of Scotland Ir & St Inst—Nov, 1905. No. 74719 D.

Lathes.

Large Electrically Driven Lathes. Frank C. Perkins. Illustrated descriptions of several electrically operated lathes, and the systems for working them. 2200 w. Ir Age—Jan. 4, 1906. No. 74221.

Machine Design.

The Design of a Combined Punching and Shearing Machine. Gives the specification and illustrated description of the design. 1000 w. Am Mach—Vol. 29. No. 2. No. 74319.

Manufacturing Plants.

Manufacturing Buildings in Cities. Walter S. Timmins. Discusses location, rents and power, forms of construction, vibration, fire proof qualities, costs of reinforced concrete, insurance on manufacturing plants, and power plants. Ills. 3800 w. Ir Age—Jan. 4, 1906. No. 74220.

Milling Machines.

English Beam-End Milling Machines. Illustrated description of large machines especially designed for milling the ends of beams of various sections. 900 w. Am Mach—Vol. 29. No. 2. No. 74316.

Molding.

Manipulation of Molding Sand. Mr. Vroman. Read before the Chicago Foundry Foremen. Discusses the manufacture and its cost, and shows that through manipulation many of the faults of molding sand can be removed. 1500 w. Foundry—Jan, 1906. No. 74559.

Permanent Molds and Carbon Cores. Henry C. Caldwell. Read before the Phila. Found. Assn. Discusses the obstacles encountered and gives a report of the experiments and final success with carbon molds and core boxes. 1600 w. Ir Age—Jan. 18, 1906. No. 74435.

Patterns.

Curves in Pattern-Work. From the *English Mechanic and World of Science.* An illustrated article giving suggestions for the making of curved patterns so as to diminish shrinkage and twist. 2000 w. Sci Am Sup—Jan. 6, 1906. No. 74196.

Pickling.

The Injurious Effect of Acid Pickles on Steel. Prof. Charles F. Burgess. Discusses the influence which such treatment exerts on the physical properties; giving a report of investigations carried out at the University of Wisconsin. Ills. 4400 w. Elec-Chem & Met Ind—Jan, 1906. No. 74240 C.

Pipe Fittings.

Piping History Repeating Itself. James Acton Miller. Refers to the use of wrought pipe bends and the saving in cost and greater safety secured; also improvements in joints and other bending work. Ills. 1500 w. Ir Age—Jan. 18, 1906. No. 74434.

Power Required to Thread, Twist, and Split Wrought Iron and Mild Steel Pipe.

I. N. Thomson. Discusses materials used, giving tabulated results of tests, the dies used, and the importance of correctly made dies, and the subject generally. 6000 w. Am Soc of Heat & Vent Engrs—Jan, 1906. No. 74340 C.

Pipes.

Deformations from the Combined Action of Internal Pressure and Bending under Tension or Compression (Zur Einbeulung bei Innenpressung und Biegung bei Zug oder Druck). Dr. Ph. Forchheimer. A mathematical investigation of the action of external forces upon tubes subjected at the same time to internal pressure. 1200 w. Zeitschr d Ver Deutscher Ing—Jan. 13, 1906. No. 74613 D.

Pneumatic Tools.

Applications of Pneumatic Power in the Machine Shop. R. Emerson. A well illustrated article discussing practical points in the installation, use, and care of air tools. 3000 w. Engineering Magazine.—Feb. 1906. No. 74676 B.

Rolling Mills.

Recent Improvements in Rolling Mills and Connections (Ueber Neuere Konstruktionen an Walzwerksantrieben und Zwischengliedern). H. Ortmann. Discussing especially the gearing and flexible coupling connections for transmitting the power to heavy rolls. 3500 w. Stahl u Eisen—Jan. 1, 1906. No. 74646 D.

Sand Mixing.

Sand-Mixing Appliances in the Foundry. E. L. Rhead. Illustrates and describes some mechanical appliances for this work. 2000 w. Mech Engr —Jan. 6, 1906. No. 74401 A.

Screws.

Some Objections to the Commercial Fillister and Flat-Head Screws. Suggests an improvement in screws used in building machinery. 500 w. Am Mach—Vol. 29. No. 2. No. 74320.

Springs.

Formulæ for Helical Springs. A. Inokuty. Develops formulæ for helical springs made of round steel wires, of square steel wires, and steel wires of rectangular section. 1000 w. Prac Engr—Jan. 5, 1906. No. 74400 A.

Throttle Valve.

Pattern for a Throttle Valve Body. H. J. McCaslin. Illustrates and describes the method used in constructing a pattern for a three way, 12 x 12 x 14½ in. throttle valve. 900 w. Foundry—Jan., 1906. No. 74556.

Tire Turning.

Tire Turning Extraordinary. George S. Hodgins. Report of a test showing the capabilities of a new driving wheel lathe carried out at the West Albany shops of the N. Y. C. R. R. Ills. 1200 w. Ry & Loc Engng—Jan, 1906. No. 74202 C.

Type-Casting.

The Pearson Type Casting Machine. Illustrated description of a simple machine for composing advertising matter. 1700 w. Ir Age—Jan. 11, 1906. No. 74301.

Welding.

The Autogenous Welding of Metals (Die Autogene Schweissung der Metalle). E. Wiss. Describing the use of the oxy-hydrogen and oxy-acetylene blow-pipes for welding metallic structures. 3500 w. Zeitschr d Ver Deutscher Ingenieure—Jan. 13, 1906. No. 74610 D.

Works.

The Works of the New Arrol-Johnston Car Co., Ltd., Paisley. Illustrates and describes these works in detail. They are exceptionally well equipped and have many interesting features. 2500 w. Engng—Dec. 22, 1905. No. 74152 A.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Bending.

A New Machine for Bending Tests. E. Probst. Illustrates and describes a machine in use in the Institute for the Testing of materials, in Zürich. 1000 w. Eng Rec—Jan. 13, 1906. No. 74388.

Black Finish.

Production of a Black Finish on Iron and Nickel. From the *Brass World.* Describes articles having a lustrous black finish said to be produced by a solution of nitrate of lead and nitrate of ammonia in connection with the electric current. 1400 w. Mech Engr—Jan. 20, 1906. No. 74734 A.

Boiler Materials.

Materials for Boilers. J. Rowland Brown. Read before the Ohio Soc. of Mech., Elec., and Steam Engrs. Present practice in the design of boilers is discussed, and the four classes of specifications of materials of boilers. Steel boiler plate, rivet steel, tubes, wrought steel, cast steel, and cast iron pressure parts are considered. 5500 w. Boiler Maker—Jan., 1906. No. 74162.

The Formation of Cracks in Boiler Plates (Die Bildung von Rissen in Kesselblechen). C. Bach. A study of the causes of cracks in boilers based upon data of the German boiler inspection associations; with illustrations and tabular results of tests. 5000 w. Zeitschr d Ver Deutschr Ing—Jan. 6, 1906. No. 74605 D.

Crushing.

Crushing Tests of the Diamonds Used in Drilling. Prof. Alexander N. Mitinsky.

Reports tests made, the results leading to the conclusion that the pressure on drilling-tools can safely be made heavier, and give an increased gain in speed of drilling. 700 w. Am Inst of Min Engrs—Jan., 1906. No. 74710.

Lubricants.

Government Tests of Lubricating Oils. A. B. Willits. An account of the specifications for lubricating oil for marine machinery and the required tests, especially the gumming test, illustrating the apparatus used. 1000 w. Ir Age—Jan. 25, 1906. No. 74539.

Metallography.

Practical Notes on Metallography (Einiges aus der Metallographischen Praxis). E. Heyn. A discussion of the applications of microscopical examinations in connection with the testing of materials, as conducted in the Royal testing laboratory at Grosslichterfelde-West, near Berlin. 4000 w. 2 plates. Stahl u Eisen—Jan. 1, 1906. No. 74645 D.

Testing.

Drop Tests on Nicked Bars (Schlagbiegeproben an Eingekerbten Stäben). C. J. Snyders & P. A. M. Hackstroh. A translation from *De Ingenieur* of drop testing work on nickel steel bars, conducted by the engineer staff of the Netherland army. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 22, 1905. No. 74619 D.

Testing Machine for Anchors and Chain Cables (Anker und Kettenprüfmaschine). Illustrating a 150-ton testing machine, designed to admit the anchors of ships, as well as heavy chain cables. 2000 w. Zeitschr d Ver Deutscher Ing—Dec. 23, 1905. No. 74601 D.

The Guillery Hardness-Testing Apparatus. Illustrates and describes three pieces of apparatus designed by M. Guillery, for testing hardness, elastic limit, and brittleness. 1800 w. Engng—Jan. 12, 1906. No. 74524 A.

MEASUREMENT.

Angles.

A Straight-Line Instrument for Trisecting an Angle. F. I. Llewellyn. Illustrated description of the instrument and its application. 600 w. Eng News—Jan. 4, 1906. No. 74174.

Planimeters.

The Theory of Planimeters. G. B. Upton. Aims to show that a theory of planimeters can be developed which shall be simple and general, with a minimum of mathematics. 1500 w. Sib Jour of Engng —Dec, 1905. No. 74551 C.

Recording Apparatus.

The "Ados" CO_2 Recorder. Illustrated description of a device whereby the gases in boiler flues may be analyzed and recorded automatically and continuously, explaining the principle on which it works. 2000 w. Engng—Jan. 12, 1906. No. 74523 A.

Shearing Stress.

Shear Stress and Permanent Angular Strain. W. C. Popplewell. Describes a series of experiments upon the torsional strength of solid and hollow shafts of cast iron, wrought iron and steel; and the results, so far as they relate to the elastic and ultimate strength properties of shafts, are discussed. 4000 w. Engr. Lond—Jan. 19, 1906. No. 74751 A.

Standard Measures.

History of the Standard Weights and Measures of the United States. Louis A. Fischer. Address at meeting of the Sealers of Weights and Measures of the United States at the Bureau of Standards. 7000 w. Am Mach—Vol. 29. No. 2. No. 74317.

Steam Flow.

High-Speed Outflow of Steam and Gases. Robert H. Smith. Discusses the subject in connection with the design of turbines, developing in tables and diagrams the law connecting variation of velocity and of section with the gradual fall of pressure along the axial line of the flow. 3000 w. Engr, Lond—Dec. 22, 1905. Serial. 1st part. No. 74154 A.

Vibrations.

The Measurement of Vibrations of Railway Cars. Frank C. Perkins. Illustrated description of the Sabouret pneumatic apparatus for the study of secondary movements on moving vehicles, in use in France. 1100 w. Ry Age—Dec. 29, 1905. No. 74098.

POWER AND TRANSMISSION.

Coal Handling.

From Canal Barge to Boiler Furnace by "Bennis" Automatic Machinery. Illustrates and describes several plants where this machcinery has been installed. 3500 w. Ir & Coal Trds Rev—Jan. 12, 1906. No. 74531 A.

Compressed Air.

An Air-Compressor Test. John Howatt. Gives a brief summarization of a test made at the Chicago & Great Western Railway shops at Oelwein, Iowa. 900 w. Power—Jan, 1906. No. 74128 C.

Compound Air Compression. Lucius I. Wightman. Considers the two practical methods in use for removing the heat of compression-jacket cooling, and intercooling. The gain of compound compression is discussed. 4000 w. Power—Jan, 1906. No. 74130 C.

Conveyors.

Improved Hoisting and Warehousing Equipment in Bremen (Neuere Förder und Lageranlagen in Bremen). M. Buhle. A combination plant for handling grain in bulk and also merchandise in sacks and other packages. 1500 w. Zeitschr d Ver Deutscher Ing—Jan. 6, 1906. No. 74608 D.

The 30-Ton Conveyor in the Port of Breslau (Die 30-t Entlade Anlage für Massengüter im städtischen Hafen zu Breslau). M. Buhle. Overhead cantilever trestle work, traveling crane and conveyor for handling mechandise in bulk. 1200 w. Glückauf—Dec. 23, 1905. No. 74653 D.

Cranes.

Cranes Driven by Single-Phase Motors. Illustrates and describes a four-ton single-phase electric travelling wharf-crane installed at Cologne, Germany. 1000 w. Engng—Dec. 22, 1905. No. 74150 A.

Drives.

Notes on Belt and Rope Drives. James Stormouth. Suggestions for efficient driving. 2200 w. Engr, Lond—Dec. 22, 1905. No. 74155 A.

Electric Driving.

Advantages and Applications of the Electric Drive. F. B. Crocker, and M. Arendt. Considers the one motor drive, group drive, and individual drive, and their proper application, and the advantages derived. Ills. 3000 w. Sch of Mines Qr—Nov., 1905. No. 74548 D.

Electricity in Cement Works. G. H. Oswald Strick. Describes the application of three-phase electric power to this class of work, and the process of manufacture. Ills. 2500 w. Elec Engr—Jan. 12, 1906. No. 74510 A.

Rough Notes on Electric Driving. Frank Broadbent. Discusses the rapid spread of electrical driving, its advantages, especially in the driving of printing machines. 1600 w. Elec Rev, Lond—Jan. 5, 1906. No. 74404 A.

Power.

Power in Tall Office Buildings. Charles H. Benjamin. The article deals with American conditions, discussing especially the cost, and distribution. 3300 w. Cassier's Mag—Jan, 1906. No. 74464 B.

Power Plants.

The Development of Energy in Power Plants (Energie-Erzeugung in Kraftwerken). Karl Rubricius. A comparison of the reciprocating engine, steam turbine, and gas engine as prime movers for power stations. 2000 w. Elektrotech u Maschinenbau—Jan. 7, 1906. No. 74661 D.

Shafts.

The Strength of Shafts Subject to Small Forces Rhythmically Applied. Charles Chree, Capt. Henry Riall Sankey, and William Ernest Wyatt Millington. A study of the effects of longitudinal, and of torsional vibrations, illustrating by examples. 7800 w. Inst of Civ Engrs. (No. 3558.) No. 74368 N.

STEAM ENGINEERING.

Boilers.

Boiler Corrosion. W. H. Booth. Illustrated explanation of defects found in shell boilers, where faults of construction made the action of corrosion especially dangerous. 1400 w. Power—Jan, 1906. No. 74126 C.

Safe Boilers. Roger Atkinson. A review of the development of steam boilers, discussing the elements of destruction, types, etc. 4500 w. Ry & Loc Engng—Jan, 1906. No. 74198 C.

Water Tube Boiler Designing as a Science. Elbridge Gary Robberts. Discusses points in the designing of these boilers to meet the requirements of marine practice. 1800 w. Marine Rev—Jan. 4, 1906. No. 74239.

See Mechanical Engineering, Materials.

Condensation.

Condensation of Steam. An illustrated explanation of the four classes of apparatus commonly employed for condensing exhaust steam. The surface, atmospheric, jet, and barometric or siphon condenser. 6000 w. Special No. Engr, U S A—Jan. 1, 1906. No. 74326 D.

Condensers—Types and Application. Franz Koester. Illustrated descriptions of types and applications made of them. 2500 w. Power—Jan., 1906. No. 74132 C.

Some Points on the Management of Condensers. G. P. Wright. Suggestions for the care and management. 1600 w. Special No. Engr, U S A—Jan. 1, 1906. No. 74327 D.

Economy.

Economy in Steam Power Plants. R. J. Durley. Read before the Canadian Ry Club. Considers the conditions which are favorable to the economical generation of steam, and the factors that favor economy in its utilization. 4500 w. Can Elec News—Jan, 1906. No. 74480.

Engines.

Ten-Thousand Horse-Power Rolling-Mill Engine. Charles R. King. Illustrated description of the engine recently built for operating the blooming and girder mills at Seraing in place of the small units hitherto employed. 1200 w. Mach, N. Y.—Jan, 1906. No. 74113 C.

Engine Tests.

Report of the Official Test of the Double Cross-Compound Engines in the Fifty-ninth Street Power Station of the Interborough Rapid Transit Company of New York. Gives a description of the conduct of the test proper and the subsidiary tests, classified as reported by tne engineer in charge. 2500 w. St Ry Jour—Jan. 6, 1906. No. 74229 C.

Exhaust Steam.

Exhaust Steam Disposal. Explains the advantages and disadvantages of both high pressure and low pressure engines and why each has its use in practice, and discusses the increase in efficiency by condensing. Ills. 1800 w. Engr, U S A—Jan. 1, 1906. Special No. No. 74322 D.

Feed Water.

Feed-water Heating. An illustrated article considering the classes and types of feed-water heaters, the saving effected, and matters of related interest. 4200 w. Engr, U S A—Jan. 1, 1906. Special No. No. 74323 D.

Water Softening for Boiler Use. T. W. Snow. A short paper and discussion on the need of removing scale forming substance from the water before it is fed to the boilers. Ills. 3300 w. Jour W Soc of Engrs—Dec, 1905. No. 74555 D.

Flue-Gases.

A Portable Apparatus for the Analysis of Flue-Gases. Charles Joseph Wilson. Illustrates and describes an apparatus employed in all the trials carried out by the recent Admiralty committee on Naval Boilers, with good results. 1700 w. Inst of Civ Engrs. (No. 3580.) No. 74355 N.

Forced Draft.

Forced Draft for Boilers. L. J. Wing. Advocates the use of forced draft, and calls attention to some fan applications. 1000 w. Am Soc of Heat & Vent Engrs—Jan, 1906. No. 74338 C.

Furnace Flues.

Tests on the Elasticity of Furnace Flues with Single Corrugations. (Versuche über die Elastizität von Flammrohen mit einzelnen Wellen). C. Bach. Data and results of tests on the Pommée type of flue, containing two deen corrugations in a length of about a metre. 1200 w. Zeitschr d Ver Deutscher Ing—Dec. 23, 1905. No. 74603 D.

Governors.

An Automatic Multi-Stage Turbine Governor. Henry F. Schmidt. Explains the three general ways of accomplishing the variation of steam supply in accordance with the load, and gives an illustrated description of a new type of governor and its operation. 1400 w. Power—Jan., 1906. No. 74131 C.

Governor Springs. H. R. Hall. Gives a chart for determining the dimensions of a spring for a governor, with information in regard to its use, and illustrated by examples. 1800 w. Prac Engr—Dec. 29, 1905. No. 74283 A.

Oil-Burning.

A Simple Oil-Burning Equipment. Courtenay DeKalb. Illustrated description of the equipment installed at the Exposed Treasure mill, Mojave, Calif. 600 w. Eng & Min Jour—Jan. 13, 1906. No. 74380.

Piping.

Piping Plans for the Onondaga County Court-House, Syracuse, New York. Charles L. Hubbard. Illustrates and describes the high-pressure and exhaust piping of the power and heating plant in the new court-house. Some of the features are of exceptional interest. 2200 w. Power—Jan., 1906. No. 74125 C.

Pistons.

Steam Engines with Heated Pistons. (Dampfmaschinen mit geheiztem Kolben). Julius Divis. Describing practical attempts to reduce cylinder condensation by introducing live steam into the interior of the piston of a steam engine. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 13, 1906. No. 74652 D.

Steam Flow.

See Mechanical Engineering, Measurement.

Steam Production.

Distribution of Steam Production in a Locomotive Boiler. Translated from *La Revue Generale*. Gives calculations showing approximately the part played in the total steam production by the direct heating surface of the firebox, and by the tubes. 3800 w. Ry Age—Jan. 12, 1906. No. 74344.

Stoker.

The Shontz Stoker. Illustrates this stoker as applied to stationary boilers. It consists of a hopper into which the coal is fed; a small wheel forces the coal down on to a chain which carries it into the fire box. 900 w. Ry Mas Mach—Jan., 1906. No. 74112.

Turbines.

Interesting Test of a Curtis Steam Turbine. Reports an economy test of a 500 kw Curtis steam turbine installed in the Oshkosh, Wis., Gas Light Co.'s plant. 2000 w. Power—Jan., 1906. No. 74129 C.

Note on Steam-Turbines. Capt. H. Riall Sankey. Gives diagrams illustrating the production of motion energy in steam-turbines of various types, and the conversion of this energy into mechanical work, with explanatory notes. 1400 w. Engng—Jan. 5, 1906. No. 74415 A.

Steam Turbines with Velocity and Pressure Stages (Dampfturbinen mit Geschwindigkeitsstufen und mit Druckstufen). Fritz Krull. Comparing the efficiency of multiple stage steam turbines with velocity drop and those with pressure drop in the successive stages, as discussed by Prof. Rateau at Liége. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 29, 1905. No. 74621 D.

Tests of DeLaval Steam-Turbine. Thomas B. Morley. A report of an investigation carried out under the auspices of the Carnegie Trust. Explains the object, describing the apparatus and method of conducting trials, giving results. Ills. 2700 w. Engng—Dec. 29, 1905. No. 74298 A.

The Steam Turbine. Henry Y. Haden. Gives a short history of the turbine, and a description of the most prominent types in the service in America, with remarks on durabilities and economies. 2500 w. Jour of Elec—Jan., 1906. No. 74308 C.

Turbine Machinery. S. A. Everett. Abstract of a paper read before the S. Wales Inst. of Engrs. Briefly reviews the history of the turbine and describes the DeLaval turbine in the present number. Ills. 2300 w. Min Jour—Dec. 23, 1905. Serial. 1st part. No. 74147 A.

See Electrical Engineering, Generating Stations.

MISCELLANY.

Aeronautics.

The Aero Club of America's Exhibit of Aeronautical Apparatus. Illustrates and describes some of the interesting exhibits recently shown in connection with the Sixth Annual Automobile Show, in New York City. 1400 w. Sci Am—Jan. 27, 1906. No. 74572.

The Stability of Aeroplanes and the Rational Construction of Sustaining Planes (Sur la Stabilité des Aéroplanes et la Construction Rationelle des Plans Sustenbateurs). Edmond Seux. An examination of the problem of longitudinal stability, with especial reference to the early work of Penaud. 1500 w. Comptes Rendus—Jan. 8, 1906. No. 74640 D.

The "White Flyer"—The Motor Driven Aeroplane of the Brothers Wright. States what the Wright Brothers have accomplished, the means by which they have effected it, etc. Ills. 3000 w. Auto Jour—Jan. 6, 1906. No. 74395 A.

Congress.

The International Congress of Applied Mechanics at Liége (Congrès Internationale de Mécanique Appliquée, Tenu à Liége). Aime Witz. A general review of the discussions at the Mechanical congress at the Liége exposition. Two articles, 6000 w. Génie Civil—Dec. 16, 23, 1905. No. 74623 each D.

Mechanical Plant.

The Mechanical Plant of the Hotel Belmont, New York City. Briefly outlines the interesting features of this structure on the corner of 42nd St. and Park Ave. and describes the extensive plant that has been installed. Ills. 4800 w. Eng Rec—Dec. 30, 1905. Serial. 1st part. No. 74-137.

Review.

Mechanical Engineering. An editorial review of the year 1905, considering railways; marine, stationary and gas engines; suction gas producers; gas turbines, motor cars, and machine tools. 5000 w. Engr., Lond—Jan. 5, 1906. No. 74426 A.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

Colorado Anthracite. Prof. Arthur Lakes. An illustrated article describing the fields of the state and the influence of eruptive rocks in metamorphosing the bituminous deposits. 2000 w. Mines & Min—Jan, 1906. No. 74249 C.

Breaker.

A Concrete Breaker. Illustrated description of the application of reinforced concrete construction in building the Pine Hill breaker, near Minersville, Pa. 2500 w. Mines & Min—Jan., 1906. No. 74241 C.

Coal Cutter.

A New English Coal Cutter. James Tonge. An illustrated description of the "Little Hardy" undercutting and shearing machine, the method of setting and operating. 1800 w. Mines & Min—Jan., 1906. No. 74246 C.

Coal Trade.

See Industrial Economy.

Coke.

Coke Making in the United States. Edward W. Parker. Reports recent developments in various coking districts to meet present and future requirements. 3500 w. Ir Age—Jan. 4, 1906. No. 74215.

Fuel Economy.

Fuel Economy at Bituminous Coal Mines in Pennsylvania. C. E. Watts. Reviews briefly the application of machinery to mining, showing that the equipment is not always economical, and pointing out causes of waste of energy. Describes the remedy applied at the Eureka mines, at Windber, Pa. Discussion. 5000 w. Pro Engrs' Soc of W Penn—Jan., 1906. No. 74540 D.

Fuel Value.

Some Experiments on the Fuel Value of Bituminous Coal Ashes. Henry Fay and F. W. Snow. An account of experiments made to determine the exact amount of unburned coal being thrown away in ordinary soft coal ashes. The expense of recovery would exceed the profit. 1500 w. Tech Qr—Dec., 1905. No. 74586 E.

Illinois.

The Coals of Illinois. S. W. Parr. Reports an increase in the coal output and gives information concerning the deposits, their character, etc. 1500 w. Eng & Min Jour—Jan. 13, 1906. No. 74384.

Indiana.

Indiana Coals. R. P. King. Read before the Indiana Engng Soc. Reviews the growth of the coal industry, the state ranking among the first six of the coal producing states. Gives information concerning the quality, heating value, etc. 3000 w. Eng Rec—Jan. 27, 1906. No. 74772.

Indian Territory.

Asphaltic Coals in the Indian Territory. W. R. Crane. Describes the deposits and the methods of prospecting and mining. Ills. 4200 w. Mines & Min—Jan., 1906. No. 74245 C.

Natal.

Coal in Natal. A report of the coal industry, which is of importance, and information concerning the quality of the coals. 1800 w. Engng—Jan. 5, 1906. No. 74421 A.

Report.

Coal. Reports of the production and trade, from all parts of the United States, by Frederick Hobart, E. Morrison, George H. Cushing, S. F. Luty, L. W. Friedman, J. E. Sheridan, and William Nelson Page. 15000 w. Eng & Min Jour—Jan. 6, 1906. No. 74272.

Separator.

A Revolving Spiral Separator. Illustrated description of a new apparatus being installed for removing slate from anthracite coal at the Truesdale breaker of the D., L. & W. Co. 1200 w. Mines & Min—Jan., 1906. No. 74250 C.

Shipping.

A New Anti-Breakage Coal Shipper. Illustrated description of an appliance invented by James Rigg, aiming to avoid breakage in the trainshipping of coal. 1000 w. Col Guard—Jan. 12, 1906. No. 74521 A.

Transformation.

Hypothesis to Account for the Transformation of Vegetable Matter into the Different Grades of Coal. Marius R. Campbell. Gives a working hypothesis embodying the provisional conclusions of the writer, in explanation of the various grades found in different localities. Heat is considered the principal cause, affected by conditions. 3000 w. Ec Geol—Oct., 1905. No. 74590 D.

COPPER.

Coeur d'Alenes.

The Copper Deposits of the Coeur d'Alenes. A description of this mining district in Idaho with outline map showing copper belt, and an account of development. 3500 w. Min Wld—Jan. 20, 1906. No. 74490.

Copper Trade.

See Industrial Economy.

Electric Refining.

See Electrical Engineerng, Electrochemistry.

Enrichment.

Secondary Enrichment in Ore-Deposits of Copper. James Furman Kemp. Reviews the chief copper ores, with comments upon them, aiming to stimulate close study of their succession in formation. 5000 w. Ec Geol—Oct., 1905. No. 74589 D.

Siberia.

The Spassky Copper Mine, Ltd. Edward Walker. Gives details of the location and history of this mine in Siberia, describing the latest developments. 1200 w. Map & plan. Eng & Min Jour—Dec. 30, 1905. No. 74107.

GOLD AND SILVER.

Assay Values.

Tables for Calculating Assay Values for Gold and Silver in Ores, etc. George T. Holloway. Gives the tables used by the author for some years in calculating assay values, with explanatory notes. 3000 w. Min Jour—Jan. 13, 1906. No. 74520 A.

Australia.

Occurrence of Albite in the Bendigo Veins. Waldemar Lindgren. Information concerning the discovery of albite with quartz from the gold-bearing veins of Bendigo, tending to confirm the relationship of these deposits to the gold-quartz deposits of California. 200 w. Ec Geol. Nov., 1905. No. 74700 D.

The Indicators of Ballarat. Prof. J. W. Gregory. Describes briefly this interesting goldfield, explaining the indicator line and giving an account of its discovery. Ills. 2200 w. Min Jour—Jan. 20, 1906. No. 74743 A.

The South Kalgurli Company's System of Ore Treatment. Arthur C. Claudet. Gives a diagram and description of the ore treatment at the new plant which handles 230 short tons per day. 1200 w. Eng & Min Jour—Jan. 20, 1906. No. 74472.

California.

The Mojave Mining District of California. Charles E. W. Bateson. An illustrated description of the location, climate and vegetation, topography, rocks and their origin, veins and their formation. 4800 w. Am Inst of Min Engrs—Jan, 1906. No. 74715 C.

Colorado.

The Gold Deposits of Plomo, San Luis Park, Colorado. Charles Godfrey Gunther. Gives a general illustrated description of the district, its geology, ore bodies, etc. 3000 w. Ec Geol—Nov, 1905. No. 74598 D.

Cripple Creek.

The Metallurgy of Cripple Creek, Colorado, Ores. Godfrey D. Doveton. Gives short accounts of the treatment of the various classes of ore. 5400 w. Min Jour—Dec. 23, 1905. No. 74148 A.

Cyanide.

Cyanidation During 1905. Charles H. Fulton. A review of the progress during the year, especially the treatment of slimes, the application to silver ores, and the successful treatment of cupriferous gold and silver ores. 4500 w. Eng & Min Jour—Jan. 13, 1906. No. 74381.

Notes on the Cyanide Process. R. Stuart Browne. An explanation of this process, considering the crushing of the ore, dissolving the gold and silver, precipitation, refining, etc. 5000 w. Min Wld—Dec. 30, 1905. No. 74118.

The Cyanide Process at Guanajuato. Francis J. Hobson. An account of tests made to determine the best method of extraction for these gold and silver ores. 1500 w. Min & Sci Pr—Jan. 6, 1906. No. 74367.

The Importance of Fine-Grinding in the Cyanide-Treatment of Gold- and Silver-Ores. Frederick C. Brown. Calls attention to the importance of fine-grinding in the treatment of comparatively low-grade ores, giving information and results of experiments. 2200 w. Am Inst of Min Engrs—Jan., 1906. No. 74712.

Distillation.

The Distillation of Gold (Sur la Distillation de l'Or). Henri Moissan. A description of the successful experiments of the author in the volatilisation and distillation of gold and gold alloys in the electric furnace. 2500 w. Comptes Rendus—Dec. 11, 1905. No. 74637 D.

Dredging.

Gold Dredging in 1905. J. P. Hutchins. A review of the progress in this business, the failures and the causes, practice and dredge design, sampling, etc. 3000 w. Eng & Min Jour—Jan. 20, 1906. No. 74471.

Enrichment.

Secondary Enrichment. Sydney Fry. An account of researches at the Britannia gold mine in New Zealand. 1600 w. Aust Min Stand—Dec. 20, 1905. No. 74466 B.

Goldfield, Nev.

Deeper Workings of the Goldfield, Nev., Mines. A. G. Hillen. Gives details of the more important properties of this district, showing the richness of the mineral veins in nearly all the deeper workings. 3800 w. Min Wld—Jan. 13, 1906. No. 74373.

Japan.

Gold Mining in Japan. A. R. Weigall. Read before the Inst, of Min. & Met. (Abstract). Gives historical, geographical, and geological information, describing the deposits, mining methods, and ore treatment. 3000 w. Min Jour—Dec. 30, 1905. Serial. 1st part. No. 74293 A.

Mexico.

The Sahuayacan Mining District, Mexico. John C. Treadwell. Gives the location and geology of this district, with information concerning the mines, deposits, etc. Silver, gold, lead, copper, bismuth, antimony, iron and manganese are found, but the principal values are in gold. Ills. 3000 w. Eng. & Min Jour—Dec. 30, 1905. No. 74109.

Nevada.

South Central Mining Districts of Nevada. A. G. Hillen. A review of the more active operations of the Bullfrog district. 3500 w. Min Wld—Dec. 30, 1905. No. 74117.

New Zealand.

New Zealand's Premier Gold Mine. An account of the Waihi mine and its wonderful progress during the past sixteen years. Ill. 2500 w. N Z Mines Rec—Nov. 16, 1905. No. 74124 B.

Ore Treatment.

The South Kalgurli Company's Ore Treatment Plant. Arthur C. Claudet. Describes this new plant which treats 230 short tons per day by dry crushing, roasting, grinding and amalgamating, agitating with cyanide and filter pressing. 1300 w. Min Jour—Dec. 23, 1905. No. 74146 A.

Progress in Gold-Ore Treatment. During 1905. Alfred James. A review of the main features which have been in the direction of finer crushing and the treatment of slimes. 3200 w. Eng & Min Jour—Jan., 1906. No. 74267.

Placers.

Deep Placer Deposits of Victoria. H. L. Wilkinson. Discusses the principles which have affected the value of the regularly defined "deep leads'" Maps. 2500 w. Eng & Min Jour—Dec. 30, 1905. No. 74108.

Pockets.

A Big Pocket. John B. Farish. A brief account of the finding of a big nugget in the Monumental mine, California. 1000 w. Min & Sci Pr—Jan. 13, 1906. No. 74-492.

Pumping Plant.

Large Pumping Plant at Tasmania Gold Mine. Frank C. Perkins. Illustrated description. 800 w. Mines & Min—Jan., 1906. No. 74251 C.

Reports.

See Industrial Economy.

Silver-Lead.

Coppabella Mining Field. Joseph E. Crane. A report to the New South Wales Mines Department on this silver-lead field. 3000 w. Aust Min Stand—Dec. 6, 1905. Serial. 1st part. No. 74446 B.

South Africa.

The Transvaal. W. Fischer Wilkinson. A report of the mining industry in the Transvaal for 1905, showing increase in production and giving much information. 3700 w. Eng & Min Jour—Jan. 13, 1906. No. 74382.

Temiskaming.

The Cobalt-Nickel Arsenides & Silver Deposits of Temiskaming. Information from a report by Prof. Willet G. Miller, Provincial Geologist of Ontario. Ills. 2300 w. Can Min Rev—Jan., 1906. No. 74498 B.

Utah.

Structural Features of the Ontario Mineral Belt, Park City, Utah. Walter P. Jenney. Describes this region of great interest to the geologist, and valuable mines of silver-lead ores. 2700 w. Min & Sci Pr—Jan. 6, 1906. No. 74366.

Veins.

Are the Quartz-Veins of Silver Peak, Nevada, the Result of Magmatic Segregation? John B. Hastings. Gives description of the quartz occurrences of the Silver Peak mines, discussing their origin. 2700 w. Am Inst of Min Engrs—Jan., 1906. No. 74711.

IRON AND STEEL.

Bessemer.

The Genesis of the Bessemer Process. From Sir Henry Bessmer's recently published autobiography. An account of the writer's researches. Ills. 4500 w. Ir & St Mag—Dec., 1905. No. 74180 D.

Briquetting.

The Briquetting of Iron Ore and Testing of the Blocks (Die Brikettierung der Eisenerze und die Prufung der Erzziegel). Dr. H. Wedding. Discussing the various binding substances for uniting the ore into blocks, and the resistance of the briquettes to breaking down in the furnace. Two articles, 5000 w. Stahl u Eisen—Jan. 1, 1906. No. 74644 each D.

Carbon Determination.

Determination of Carbon in Steel by Direct Ignition with Red Lead. Charles Morris Johnson. Gives the writer's experience with this method, with notes on the reasons for its adoption for routine combustion analysis. Ills. 4000 w. Pro Engr's Soc of W Penn—Jan., 1906. No. 74544 D.

Cementation.

Notes on Cementation Processes (Einiges über das Zementieren). A. Ledebur. A review of the paper of Guillet before the *Société des Ingenieurs Civils de France* in 1904, discussing the operations of case-hardening by cementation. 2000 w. Stahl u Eisen—Jan. 15, 1906. No. 74649 D.

Dry-Air Blast.

The Application of Dry-Air Blast to the Manufacture of Iron. Edward de Mille Campbell. A discussion of the paper by James Gayley. Tables and curves showing the influence of variations in the dew-point are given. 3000 w. Am Inst of Min Engrs—Jan., 1906. No. 74713 C.

Electric Smelting.

See Electrical Engineering, Electro-chemistry.

Iron Ores.

Genesis of Lake Superior Iron Ores. Charles Kenneth Leith. A summary of conclusions presented in U. S. Geol. Surv. monographs, with a report of later work and a summary of the general geology of the ores and ore-bearing series. 7500 w. Ec Geol—Oct., 1905. No. 74592 D.

The Hill Iron Ore Properties. Dwight E. Woodbridge. Explains the extent of the Hill holdings, their relations to the Steel Corporation, the advantageous position of the Hill interests and related matters of importance. 3500 w. Ir Age—Jan. 4, 1906. No. 74219.

Iron Trade.

See Industrial Economy.

Manganese.

Manganese, It's Prices and Uses. Dr. J. Ohly. Gives a copy of the last report issued by the Carnegie Co. in regard to this product, and discusses the changes of importance. 1200 w. Min Wld—Jan. 13, 1906. No. 74372.

Meeting the Insufficient Supply of Manganiferous Ores (Die Deckung des Bedarfs an Manganerzen). Wilhelm Venator. A review of the sources of manganiferous ores in various parts of the world, and the extent to which the demand for steel manufacture can be met. Serial. Part I. 3000 w. Stahl u Eisen—Jan. 15, 1906. No. 74648 D.

Mexico.

Iron Manufacture in Mexico. John Birkinbine. Describes the topography of Mexico and the bearing on iron and steel manufacture, and gives information concerning the industry. The conditions are considered encouraging. 2200 w. Ir & St Mag—Jan., 1906. No. 74535 D.

Pig Iron.

See Industrial Economy.

Plate Mills.

The Central Iron and Steel Company's Plate Mills at Harrisburg, Pa. Reviews the history of these works and gives an illustrated detailed description. 4000 w. Ir Age—Jan. 4, 1906. No. 74222.

Rolling Mills.

See Mechanical Engineering, Machine Works and Foundries.

Spiegeleisen.

An Old Specimen of American Spiegeleisen. Frank Firmstone. Description and analysis of a piece of spiegeleisen, supposed to have been made at the old charcoal furnace which once stood at the village of Andover, N. J. 1000 w. Am Inst of Min Engrs—Jan., 1906. No. 74709.

Steel Plates.

Manufacture of Steel Plates. G. M. Kohler. The present article considers the production of the ingots, the molds, casting, stripping, reheating, &c. Ills. 2200 w. Boiler Maker—Jan., 1906. Serial. 1st part. No. 74161.

MINING.

Accidents.

Safety Measures in Mining. Donald Macaulay and Louis G. Irvine. The present paper discusses measures in cases of ordinary accidents, and measures in cases of gassing. 7000 w. Jour Chem, Met & Min Soc of S Africa—Nov., 1905. No. 74399 E.

Agriculture.

The Relations of Mining and Metallurgy to Agriculture. F. W. Traphagen. Abstract of a paper read before the West. Assn. of Tech., Chem & Met. Discusses cases of damage caused by mills and smelters to crops and farm animals, with special reference to conditions in Montana. 2500 w. Min Jour—Jan. 6, 1906. No. 74409 A.

Alaska.

Present Conditions in Southern Alaskan Mining Districts. Wm. M. Brewer. A fully illustrated review of mining work in Southern Alaska, discussing especially gold and copper production and prospects. 4000 w. Engineering Magazine—Feb., 1906. No. 74673 B.

Australia.

Eastern States of Australia. F. S. Mance. A review of a most satisfactory year, giving statements in regard to gold, silver, copper, tin, coal, and other minerals. 2200 w. Eng & Min Jour—Jan., 1906. No. 74264.

Blasting.

An Improved Form of Electric Exploder for Blasting. J. Schuermann. Gives an illustrated detailed description of the ordinary electric exploder, and also of the improved type explaining its advantage. 1000 w. Eng News—Jan 25, 1906. No. 74563.

Brazil.

The Geology of the Diamond and Carbonado Washings of Bahia, Brazil. Orville A. Derby. Translation of a report to the Governor, and the most important paper thus far published on the geology of this region. 3000 w. Ec Geol—Nov., 1905. No. 74597 D.

British Columbia.

British Columbia. E. Jacobs. A report of the mineral production of the year, the improvements and prospects. 1500 w. Eng & Min Jour—Jan. 6, 1906. No. 74265.

California.

The Mining Industries of California. Charles G. Yale. A brief review of the mining industries of the State during the year of 1905. 2500 w. Eng & Min Jour—Jan. 6, 1906. No. 74257.

Colorado.

Metal Mining in Colorado During 1905. George E. Collins. A report of the year 1905, giving details of the various districts. 2300 w. Eng & Min Jour—Jan. 6, 1906. No. 74262.

Concentrator.

A Lead and Zinc Concentrator at Roseberry, B. C. Alfred W. Dyer. Brief illustrated description. 1500 w. Can Min Rev—Jan., 1906. No. 74497 B.

Crushing.

The Effect of Variation in the Speed of Crushing Machinery Upon the Production of Undersized Material. H. W. Gartrell. An investigation of this subject showing that while decrease of speed tends to decrease the production of undersized material, it does so in a degree so small that it is disproportionate to the disadvantage of decreased capacity. 1200 w. Sch of Mines Qr—Nov., 1905. No. 74546 D.

Death Valley.

Explorations in Death Valley District. Col. E. F. Browne. Describes the geology and general appearance of this district and the conditions to be met. Information concerning the deposits and dangers to be encountered. 3300 w. Min Wld—Jan. 20, 1906. No. 74488.

Deep Drilling.

Modern Deep Drilling Practice in Europe. Will Halder. Sketches the development of modern methods of deep drilling, with special reference to those which depend upon a succession of quick blows with decreased height of fall. 2000 w. Min Mag—Jan., 1906. No. 74349 C.

Divining Rods.

Unscientific and Scientific Divining Rods. George M. Hopkins. An illustrated article describing principally the scientific devices used in locating metal ores. 1800 w. Sci Am Sup—Jan. 20, 1906. No. 74443.

Door Opener.

A Hydraulic-Pneumatic Mine Door Opener. L. L. Logan. Illustrated description of a safety derailing latch for operating any door against any pressure. 3000 w. Mines & Min—Jan., 1906. No. 74242 C.

Electric Plants.

Electrical Installation at the Hasard Colliery, Belgium. M. R. A. Henry. Abstract of a paper before the Min. Cong. at Liége. Illustrated description. 900 w. Col Guard—Dec. 29, 1905. No. 74295 A.

Some Electric Installations in European Mines. Emile Guarini. Illustrates and describes different kinds of apparatus for chain and locomotive haulage, hoisting and ventilating. 2500 w. Mines & Min—Jan., 1906. No. 74243 C.

Explosives.

The Nature of Nitro Explosives (Ueber das Wesen der Nitro-Sprengstoffe). O. Stegemann. Discussing especially the chemistry and action of the nitro-glycerin explosives used in mining operations. 3000 w. Glückauf—Dec. 30, 1905. No. 74654 D.

Fire Damp.

Mine Temperatures and the Influence of Natural Weather Conditions Upon the Production of Firedamp (Ueber Grubenlufttemperaturen und den Einfluss des Naturlichen Wetterzuges auf die Wetterwirtschaft bei Einigen Tiefen Schächten des Brüxer Braun Kohlen reviers). L. Stadlmayr. Data showing the relation of the release of mine gases to external weather conditions. Serial. Part I. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 6, 1906. No. 74651 D.

Tests of Devices to Protect Electric Apparatus from Firedamp (Versuche zwecks Erprobung der Schlagwettersicherheit besonders Geschützter Elektrischer Motoren und Apparate). H. Beyling. An illustrated account of tests in the experimental tunnel at Gelsenkirchen upon the ignition of firedamp from electrical apparatus. Serial. Part I. 3000 w. Glückauf—Jan. 6, 1906. No. 74655 D.

The Beard-Mackie Light-Indicator for the Measurement of Marsh-Gas in Collieries. M. H. Harrington. An illustrated description of this indicator, which has been successfully tested in practice. 2800 w. Am Inst of Min Engrs—Jan., 1906. No. 74714.

Fires.

Controlling and Extinguishing Fires in Pyritous Mines. Lewis T. Wright. Explains the causes of such fires, and the system adopted by the writer for extinguishing and controlling them. 1800 w. Eng & Min Jour—Jan. 27, 1906. No. 74727.

Fissures.

The Fissure System of the Ontario Mineral Belt. W. P. Jenney. Description, with diagrams, of the mineral bearing veins and the verticals. 2200 w. Min & Sci Pr—Jan. 13, 1906. No. 74493.

Idaho.

Mining in Idaho in 1905. Robert N. Bell. A review of the mining developments for the year, not including the Couer d' Alene district, which is reported separately. 2300 w. Eng & Min Jour—Jan. 6, 1906. No. 74258.

Japan.

The Mining Industry in Japan. W. J. Johnston. Statistical data concerning the growth of the mining industry in Japan, and notes on the present status of the industry. 4000 w. Min Mag—Jan., 1906. No. 74348 C.

Joplin.

Structural Features of the Joplin District. C. E. Siebenthal. Reviews the work that has been done in studying this district, and states the conclusions reached. Also discussion by H. Foster Bain. 4400 w. Ec Geol—Nov., 1905. No. 74595 D.

Klondike.

The Klondike in 1905. J. P. Hutchins. Discusses the causes of the lessened production, the mining methods, water supply, mining laws and regulations. 2500 w.

Eng & Min Jour—Jan. 6, 1906. No. 74256.

Mexico.

Fine Grinding Ore by Tube-Mills, and Cyaniding at El Oro, Mexico. G. Caetani and E. Burt. Gives the results of a series of experiments and tests made in view of determining the economical limit to which the fine grinding of ore by tube-mills could be carried. 15800 w. Am Inst of Min Engrs—Jan., 1906. No. 74716 D.

Mexico. James W. Malcolmson. A report of the mineral industry and its progress during the past year. 2000 w. Eng & Min Jour—Jan. 6, 1906. No. 74266.

Mining Hints.

Economic Mining Hints. P. A. Leonard. Emphasizes the importance of good management, and a study of local conditions, the cost of transportation and reduction. 1700 w. Min Wld—Jan. 20, 1906. No. 74487.

Mining Law.

The American Law Relating to Minerals. Charles H. Shamel. An exposition of that part of American mining law that deals with the definitions and the legal conception of the terms mineral, ore, &c., as used in law. 10800 w. Sch of Mines Qr—Nov., 1905. No. 74545 D.

The Present Mining Law of Pennsylvania. Thomas K. Adams. Read before the W. Penn. Cent. Min. Inst. Discusses whether it should be revised, and how, suggesting some changes. 2800 w. Mines & Min—Jan., 1906. No. 74247 C.

Mining Problems.

The Graphical Solution of Mining Problems. Leo Gluck. Illustrates and describes an apparatus designed by the writer for the solution of many problems without requiring the use of mathematical formulæ. 1800 w. Min Wld—Jan. 13, 1906. No. 74371.

Montana.

Montana in 1905. A. Selwyn-Brown. A report of the year, giving information in regard to the output of copper, silver, gold, zinc, coal, and sapphires. 1800 w. Eng & Min Jour—Jan. 6, 1906. No. 74263.

Nevada.

Nevada in 1905. A. Selwyn-Brown. An interesting review of a prosperous year, with illustrations of Tonopah. 2000 w. Eng & Min Jour—Jan. 6, 1906. No. 74261.

New Zealand.

Mining and Metallurgical Methods of the Waihi Gold Mining Company, New Zealand. F. N. Rhodes. Illustrated detailed description of the processes adopted at the works of the Waihi Gold Mining Company for the mining and treatment of gold ores. 2800 w. Min Mag—Jan., 1906. No. 74347 C.

Ore Deposits.

Ore Deposition and Deep Mining. Waldemar Lindgren. A review of what has been accomplished in determining the mode of disposition of ores, and the probabilities of finding workable ores in depths. 5000 w. Ec Geol—Oct., 1905. No. 74591 D.

The Chemistry of Ore-Deposition—Precipitation of Copper by Natural Silicates. Eugene C. Sullivan. A report of experimental work. 2000 w. Ec Geol—Oct., 1905. No. 74593 D.

The Phase Rule and Conceptions of Igneous Magmas—Their Bearing on Ore Deposition. Thomas Thornton Read. Presents some considerations relating to rock magmas, and the laws which govern them, in relation to their bearing on the formation of ores. 6000 w. Ec Geol—Nov., 1905. No. 74594 D.

Ore Loading.

Electrically Operated Ore Loading Plants and Wire Rope Tramways. Frank C. Perkins. Illustrates and describes some improved methods employed for ore loading, and the power utilized. 2000 w. Min & Sci Pr—Dec. 23, 1905. No. 74119.

Respirator.

Respiratory Apparatus for the Exploration of Localities Filled with Irrespirable Gases (Appareil Respiratoire pour l'Exploration des Milieux Remplis de Gaz Irrespirable). M. Guglielminetti. A portable device, using caustic potash to absorb the carbonic acid from the expired air, the oxygen being supplied from a separate reservoir. 1200 w. Comptes Rendus —Jan. 2, 1906. No. 74639 D.

Rhodesia.

Mining and Mineral Industry in Rhodesia. E. H. Garthwaite. An account of this interesting portion of S. Africa, its deposits of gold, copper, lead and zinc ores, the mines and mining laws, cost of supplies. 5200 w. Min Mag—Jan., 1906. No. 74345 C.

Shafts.

Shaft Sinking in Quicksand. George C. McFarlane. Illustrates and describes a shaft in Michigan as a fine example of the successful application of a steel shoe in sinking a rectangular shaft through a heavy bed of quicksand. 1200 w. Eng & Min Jour—Jan. 20, 1906. No. 74474.

Shaft Sinking Through Sand. T. H. Mottram. Abstract of a paper before the Mining Inst. of Scotland, describing the sinking of shafts through sand at Ardeer, Ayrshire, by the pneumatic process. 2800 w. Col Guard—Dec. 29, 1905. No. 74294 A.

Sinking by the Up-Over Method. William Belfitt. Explains the conditions and describes the method adopted. Ills. 1200 w. Ir & Coal Trds Rev—Dec. 22, 1905. No. 74160 A.

Steam Pipes in Shafts. R. D. O. Johnson. Illustrates and describes an arrangement used by the writer which overcame the usual difficulties and proved satisfactory. 1000 w. Eng & Min Jour—Jan. 27, 1906. No. 74728.

Slipping Planes.

Slipping Planes in Mines. Arthur Lakes. Illustrates and describes peculiarities due to folding or faulting. 800 w. Min Rept—Jan. 4, 1906. No. 74237.

Smelting.

A Combined Siphon-Spout and Matte-Trap. Henry Harris. Illustrated description of this design which has been used continuously for some months with pleasing results. 1000 w. Eng & Min Jour—Jan. 27, 1906. No. 74731.

Tracks.

Track Construction in Mines. Leo Gluck. Abstract of a paper read before the Illinois Soc. of Engrs. & Survs. Briefly considers the switches, gauge of tracks, frog angles, &c. 600 w. Eng News—Jan. 25, 1906. No. 74569.

Tunnels.

A Colorado Mining Tunnel. Thomas Tonge. The conditions in Colorado are described, and the three tunnels now being driven are outlined, especially describing the Central Tunnel. 3000 w. Min Jour—Jan. 6, 1906. No. 74410 A.

Big Cross-Cut Tunnels of Clear Creek County, Colo. H. C. Newton. Extracts from a recent article by Gen. Frank Hall, describing briefly the Newhouse, Burns-Moore, Honest John, "Big 40," Central and Lucania, Gold Valley, Commodore, and Alvarado tunnels. 3000 w. Min Wld—Jan. 20, 1906. No. 74491.

The Lucania Tunnel. An illustrated account of this tunnel for the development of Colorado mines. 3000 w. Min Ind—Jan. 15, 1906. No. 74448.

The Newhouse Tunnel. An interesting illustrated account of this enterprise in Colorado, describing the property and the territory tributary to it. 2500 w. Min Ind—Jan. 15, 1906. No. 74447.

Turkey.

Mining in Turkey. B. Nogara. An illustrated description of the conditions of mining in the Turkish Empire. 1400 w. Min Mag—Jan., 1906. No. 74346 C.

Utah.

Mining Progress in Utah in 1905. L. H. Beason. A review of the year, showing increase in output in gold, silver and copper, especially the latter. 4000 w. Eng & Min Jour—Jan. 6, 1906. No. 74259.

Veins.

Ore-Horizons in the Veins of the San Juan Mountains, Colorado. Chester Wells Purington. Considers an occurrence in southwest Colorado, where nearly vertical metalliferous veins traverse horizontally bedded lavas and underlying sediments. 1800 w. Ec Geol—Nov., 1905. No. 74596 D.

The Problem of the Metalliferous Veins. James Furman Kemp. Presidential address to the N. Y. Academy of Sciences. An interesting discussion of metalliferous deposits, their origin, and matters of related interest. 8500 w. Ec Geol—Dec., 1905. No. 74705 D.

Virginia.

Mining of Zinc, Lead, Iron, and Coal in Virginia. Thomas L. Watson. A review of the mineral industry in the State, the production, new developments, &c. 4800 w. Eng & Min Jour—Jan. 6, 1906. No. 74260.

Winding.

A Controlling Device. Illustrated description of Nicholson's controlling device for automatically stopping a steam hoisting engine when the cage passes a given point. 1400 w. Mines & Min—Jan., 1906. No. 74248 C.

Electric Winding Considered Practically and Commercially. W. C. Mountain. Abstracts of a paper read before the Manchester Soc. of the Inst. of Elec. Engrs. A tabulated statement of the actual cost of winding by steam engines at large collieries is given, and relative estimates of the cost of winding by steam and electricity. 4000 w. Ir & Coal Trds Rev—Jan. 19, 1906. No. 74759 A.

Wisconsin.

Structural Relations of the Wisconsin Zinc and Lead Deposits. Ulysses Sherman Grant. Presents results due to detailed mapping of selected areas of this field. Describes the geology, the ore-deposits, and discusses their origin. 2200 w. Ec Geol—Dec., 1905. No. 74706 D.

Working Costs.

The Distribution of Power on Mines. C. E. Hutton. Describes the method of power account apportionment adopted at the Van Ryn mines. Tables and discussion. 7500 w. Jour S African Assn of Engrs—Nov., 1905. No. 74393 F.

MISCELLANY.

Borax.

The Borax Deposits of California. G. E. Bailey. Illustrates and describes these deposits and their development. 1200 w. Min Wld—Jan. 6, 1906. No. 74231.

Fluorspar.

Fluorspar. E. Julius Fohs. A review of the production during 1905, giving information of the different districts, methods of mining, uses, &c. 2300 w. Eng & Min Jour—Jan. 6, 1906. No. 74269.

Lead and Tin.

Lead and Tin in 1905. E. A. Caswell. A review of the markets and the causes affecting them. 2800 w. Ir Age—Jan. 4, 1906. No. 74217.

Metallurgy.

Experiments on the Metallurgical Behavior of a Mixture of Lead Sulphide and Calcium Sulphate. F. O. Doeltz. Reports the experiments and gives the conclusion reached. 1600 w. Eng & Min Jour—Jan. 27, 1906. No. 74729.

Petroleum.

Oil and Gas Development in the Mid-Continental Field in 1905. Erasmus Haworth. Reports concerning the Kansas-Indian Territory field, the development, refineries, pipe lines, &c. 6000 w. Eng & Min Jour—Jan. 13, 1906. No. 74383.

Oil Conditions in California. A statement of present conditions in the different fields. 1800 w. Am Gas Lgt Jour—Jan. 22, 1906. No. 74482.

Quicksilver.

California Quicksilver. Charles G. Yale. Reports affairs in this industry to be in a rather bad state, discusssing some of the causes. 1500 w. Eng & Min Jour—Jan. 6, 1906. No. 74270.

The Quicksilver Deposits of Brewster County, Texas. William Battle Philips. Gives an illustrated general description and detailed description of the Terlingua district and the Study Butte district. 2600 w. Ec Geol—Nov., 1905. No. 74599 D.

The Terlingua Quicksilver Deposits. H. W. Turner. Describes the general geology of the district, the deposits in the tertiary lavas, and in sedimentary rocks, and the minerals of the quicksilver lodes. Ills. 5000 w. Ec Geol—Dec., 1905. No. 74708 D.

Vanadium.

Utilizing Vanadiferous Sandstone. Dr. J. Ohly. Outlines a commercial process that might serve for the production of sodium uranate and ammonium vanadate. 2000 w. Mines & Min—Jan., 1906. No. 74244 C.

Zinc.

The Wisconsin Zinc Field. E. Hedburg. Gives the history of this region, describing the deposits and some of the mines, and the ore treatment. 3000 w. Min Wld—Jan. 20, 1906 No. 74489.

Zinc Industry, Broken Hill. Edward Laughton. Discusses the profits derivable and the different processes for recovering zinc from the tailings. 1800 w. Aust Min Stand—Dec. 6, 1905. No. 74445 B.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

How to Avoid Accidents. From a paper prepared by the Claim Department of the A., B. & C. Railroad calling attention to some of the causes of accidents and means of preventing them. 4000 w. R R Gaz—Vol. XL, No. 1. No. 74211.

Fast Trains.

The Fastest Trains in Europe and America. Arnold Kramer, in *Annalen für Gewerbe und Bauwesen.* Information concerning the fastest regular trains at the present time. 900 w. Bul Int Ry Cong—Dec., 1905. No. 74562 E.

MOTIVE POWER AND EQUIPMENT.

Brakes.

Sauvage Safety Brake. Describes this system and explains its object, reporting tests. 3500 w. Ry & Engng Rev—Jan. 20, 1906. No. 74486.

Cars.

Car Construction and Cost Records: Chicago, Milwaukee & St. Paul Railway. Describes the system of records adopted by this road and special features of the construction and repair work. 2800 w. Eng News—Jan. 25, 1906. No. 74565.

Design of Steel Cars with Reference to Repairs. A Stucki. A discussion of points that should be carefully watched in order to facilitate the repair of steel cars. 1500 w. Am Engr & R R Jour—Jan., 1906. No. 74102 C.

Steel Railway Coaches. Brief illustrated description of steel coaches for the Great Northern and City Railway. 900 w. Engr, Lond—Dec. 22, 1905. No. 74159 A.

Controversy.

Controversy Over Continuous Current and Single-Phase Systems. A review of the discussion caused by the proposed installation of the single-phase alternating current system in the electrification of the N. Y., N. H. & H. R. R. entering New

York City. 4800 w. Ry & Engng Rev—Jan. 13, 1906. No. 74376.

Cylinders.

Locomotive Cylinders. Hal. R. Stafford. Considers some of the problems in modern practice, and gives suggestions for solving them. Ills. 3000 w. Am Engr & R R Jour—Jan., 1906. No. 74100 C.

Dynamometer Car.

Note on the Dynamometer Car of the Belgian State Railway. A. Huberti and J. Doyen. Illustrated description of the car and appliances and the working. 9600 w. Bul Int Ry Cong—Dec., 1905. No. 74561 E.

Electrification.

A Note on the Electrification of Trunk Line Railways. H. Ward Leonard. Points out the advantage of electricity for freight haulage, because of the possibility of making up larger train units at a lower cost per ton mile. 1600 w. St Ry Jour—Jan. 27, 1906. No. 74725 C.

Electrification of the New York Central Terminal in and near New York City. An illustrated detailed description of the important changes, considering the organization, line, power, track, terminals and stations. Six insets. 8400 w. Ry Age—Jan. 26, 1906. No. 74721.

Electrification of the Paris-Orleans Suburban Line. Illustrates and describes the electrification of the Paris-Juvisy section. The traction is effected by electric locomotives or rail motorcars, which take continuous current at 600 volts from an outside third rail. 1600 w. Engng—Jan. 5, 1906. No. 74417 A.

The Electrical Equipment for the New York Central. Interesting letters on this subject from Mr. George Westinghouse and B. G. Lamme. 600 w. Elec Wld & Engr—Dec. 30, 1905. No. 74163.

Hospital Cars.

A Hospital Car for the Southern Pacific Ry. Illustrates and describes an unusually large and well-equipped hospital car. Also refers to this class of cars in use on other roads. 2000 w. Eng News Jan. 11, 1906. No. 74332.

Injectors.

Locomotive Injectors, Modern Practice. Strickland L. Kneass. Abstract of a paper read before the Traveling Engrs. Assn. Explains the principle upon which the injector operates, the importance of the location, the systems in use and the desirable features of the ideal modern locomotive injector. 2000 w. Ry Age—Dec. 29, 1905. No. 74099.

Locomotives.

Balanced Compound Locomotives in Service. Sanford H. Fry. Gives illustrations and describes types of these engines, presenting results obtained in actual service. Short discussion. 5500 w. S & S-W Ry Club—Nov. 16, 1905. No. 74764 E.

Contractors' Locomotives. J. F. Gairns, Reviews the conditions governing the design and construction of such engines and their field of usefulness. Ills. 3000 w. Cassier's Mag—Jan., 1906. Serial. 1st part. No. 74465 B.

Development of the Steam Locomotive. Samuel Rendell. Abstract of a paper by one of the Manchester Assn of Engrs. A review showing the growth and alteration in general appearance and comparing with engines of fifty years ago. 4000 w. Mech Engr—Jan. 20, 1906. No. 74735 A.

Experimental Locomotives for the Pennsylvania Railroad. Illustrated descriptions of engines, two of each of five types having been ordered for experimental and observation purposes. 2200 w. R R Gaz—Vol. XL, No. 1. No. 74212.

Express Locomotive for the Malmö-Ystad Railway (Schnellzuglokomotive für die Bahn Malmö-Ystad). A. Doeppner. Illustrating a special locomotive, with snowplow attachment built by Borsig for a Swedish railway. 1000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 6, 1906. No. 74606.

Four-Cylinder Locomotive for the Eastern Railway of France. H. W. Hanbury. Plate, illustration and description of a compound locomotive exhibited at the Liége Exhibition. 2200 w. Engng—Dec. 22, 1905. No. 74151 A.

Good's Locomotives on Foreign Railways. Charles S. Lake. Illustrated descriptions of types, noting features of special interest. 1500 w. Mech Engr—Dec. 23, 1905. Serial. 1st part. No. 74145 A.

Heavy American Type Locomotive, C. R. R. of N. J. Illustration, with brief description of a new heavy American type of locomotive with Walschaert valve gear. 500 w. Ry & Engng Rev—Jan. 13, 1906. No. 74375.

Heavy Eight-Wheeled Passenger Locomotive for the Central R. R. of New Jersey. Illustrated detailed description of exceedingly heavy engines of the 4-4-0 type, for passenger service over heavy grades and sharp curves. 1000 w. R R Gaz—Vol. XL, No. 3. No. 74453.

Latest Canadian Pacific 4-6-0. Illustration with description of a type of engine intended for passenger and freight service. 500 w. Ry & Loc Engng—Jan., 1906. No. 74200 C.

Mikado Type Freight Locomotives. Illustration and general data of engines built for the Deepwater Ry. Co. 300 w. Am Engr & R R Jour—Jan., 1906. No. 74104 C.

New Baltimore and Ohio Consolidation Locomotives. J. E. Muhlfeld. A statement of the features considered in the design, construction, operation, and maintenance of the E-27 class, with illustration and general dimensions. 2200 w. Am Engr & R R Jour—Jan., 1906. No. 74105 C.

New Compound Locomotives for the Great Central Railway. Illustrated description of an Atlantic (4-4-2) type three-cylinder compound passenger engine recently completed. 1000 w. Mech Engr—Jan. 20, 1906. No. 74733 A.

New Compound Locomotive on the Great Central Railway. Charles Rous-Marten. Discusses the three-cylinder compound engine just built from a design of J. G. Robinson for the fastest express service. Ills. 2500 w. Engr, Lond—Jan. 19, 1906. No. 74752 A.

Six-Coupled Engines on the Glasgow and South-Western Railway. Charles Rous-Marten. A large woodcut of this new type of engines, with drawings of the tender, and a discussion of the work of the engine. 4000 w. Engr, Lond—Jan. 5, 1906. No. 74423 A.

Six-Coupled Express Engine. Two-page drawing and brief description of bogie engine for heavy and fast service between Glasgow and Carlisle on the Glasgow & South-Western Ry. Particulars of the working will be given in the next issue 700 w. Engr, Lond—Dec. 29, 1905. No. 74299 A.

Tendencies in Locomotive Building. Editorial on the features of this work during the past year. 1000 w. Ry & Loc Engng—Jan., 1906. No. 74199 C.

Thermal Storage Locomotive. Brief illustrated description of a radial tank locomotive of the 2-4-2 type belonging to the Lancashire and Yorkshire Railway, which has been fitted with the Druitt-Halpin system of thermal storage. 300 w. Mech Engr—Jan. 6, 1906. No. 74402 A.

Railway Automobiles.

Petrol Automotor for Railway Service (Draisine à Pétrole pour Voies Ferrées). An illustrated description of the Campagne car, designed for inspection service and light emergency traction on the French railways in Tunis. 1200 w. Génie Civil—Dec. 23, 1905. No. 74628 D.

Wolseley 140 H. P. Railroad Car Motor. Illustrated description of an engine having six opposed cylinders, now installed in an experimental self-propelled coach at the Schenectady shops of the General Electric Co. 1500 w. Automobile—Jan. 4, 1906. No. 74203.

Regulating Valves.

The Dimensions of the Openings for Locomotive Regulating Valves (Ueber die Grösse der Lokomotive-Regulator Einströmöffnung). A. Langrod. A mathematical examination of the flow of steam through regulating valves in accordance with the modern theory of Gutermuth. 2000 w. Glasers Annalen—Jan. 1, 1906. No. 74615 D.

Testing Plant.

Locomotive Testing Plant at Swindon Drawings and photographs illustrating the plant of the Great Western Railway, England, with description of the mechanism. 2000 w. Engr, Lond—Dec. 22, 1905. No. 74158 A.

Valve Gear.

Walschaert Valve Gear. An explanation of the mechanism, taken from advance sheets of articles prepared by the American Locomotive Co. Gives reasons for its preference. 2500 w. Ry & Engng Rev—Jan. 6, 1906. No. 74236.

Walschaert Valve Gear. Carl J. Mellin. From an Am. Locomotive Co. pamphlet. General description, with methods of adjusting valves and of laying out the Walschaert gear. 2500 w. Am Engr & R R Jour—Jan., 1906. No. 74103 C.

NEW PROJECTS.

Extension.

The Thief River Falls Extension of the "Soo" Line. An account of an important piece of railroad construction during this last year, on the M., St. P. & S. St. M. Ry., through Minnesota and N. Dakota. Map and profiles. 1200 w. R R Gaz—Vol. XL, No. 4. No. 74580.

Philippines.

Philippine Railroad Projects. L. E. Bennett. An illustrated article giving information of work completed and proposed, the conditions, native labor, &c. 4000 w. R R Gaz—Vol. XL, No. 1. No. 74213.

Rhodesia.

The Rhodesia Railways in South Africa. Frank C. Perkins. An illustrated article describing these railways and their rolling stock. 1600 w. Sci Am Sup—Jan. 20, 1906. No. 74442.

PERMANENT WAY AND BUILDINGS.

Bridges.

See Civil Engineering, Bridges.

Culverts.

Notes on the Design and Construction of Reinforced Concrete Culverts. C. F. Graff. Discusses the advantages and economy of this type of culvert and submits designs of reinforced concrete, discussing them in detail. Ills. 3300 w. Eng News —Jan. 4, 1906. No. 74170.

Leipzig.

The New Railway Station at Leipzig (Der Neue Hauptbahnhof in Leipzig). H. Heinrich. A detailed description of the new union railway station in Leipzig, with plans of the railroad connections. Serial. Part I. 5000 w. Two plates. Glasers Annalen—Jan. 15, 1906. No. 74635 D.

Railway Work.

Railway Grading, Ditching, and Bank Building Machines. Illustrates and describes some machines of great importance in railway construction. 1200 w. Eng News—Jan. 4, 1906. No. 74173.

Shops.

Sedalia Shops, Missouri Pacific Ry. Illustrated detailed description of the shops and their equipment. The group system of motor driving is utilized. 6800 w. Ry & Engng Rev—Jan. 6, 1906. No. 74235.

The Conduct of American Repair Shops (Aus dem Betriebe Amerikanisher Reparaturwerkstatten). G. Dinglinger. Describing especially the methods of railroad shops in the United States, with forms of time cards, job and material tickets, inspection forms, and general works management system. 6000 w. Glasers Annalen—Dec. 15, 1905. No. 74614 D.

The New Shops of the Canadian Pacific Railway at Winnipeg. Wheeler Carr. Illustrated description of shops for repair work which present features of interest. 2800 w. Engr, U S A—Jan. 1, 1906. No. 74321 D.

Signaling.

Mackenzie & Holland's Improved Sykes Block Signal, East Bengal State Railways. G. K. Rogers. Read before the Ry Signal Assn. Diagram and description of this system and its workings. 700 w. Ry & Engng Rev—Jan. 20, 1906. No. 74485.

Signal Arrangements for the New York Central Electrified Zone. Extracts from a paper by W. H. Elliott in *Railway Men* for Jan. Explains some details of the signaling plans. 2700 w. R R Gaz—Vol. XL, No. 2. No. 74330.

Terminals.

Terminal Improvements of the Boston & Maine R. R. in Boston. Illustrated account of recent improvements at this important terminal, which covers 637 acres. 1600 w. Ry & Engng Rev—Jan. 20, 1906. No. 74484.

The East Altoona Freight Terminal of the Pennsylvania Railroad. Illustrated detailed description of these recently enlarged yards, which are said to handle the largest freight tonnage of any single system of freight yards in the world. 4200 w. Ry Age—Jan. 19, 1906. No. 74470.

The New Hoboken Freight Terminal of the Lackawanna R. R. Plan and description of the proposed arrangement of freight terminal piers and slips. 1800 w. Eng Rec—Jan. 6, 1906. No. 74278.

Tunnels.

See Civil Engineering, Construction.

TRAFFIC.

Demurrage.

The Implements and Causes of Demurrage Controversies. Ashley J. Elliott. Discusses some of the problems of car service. 4500 w. Pro St Louis Ry Club—Dec. 9, 1905. No. 74179.

Rates.

Government Regulation of Railway Rates. B. H. Meyer. Read before the Am. Econ. Assn. An argument in favor of government control of railways. 4300 w. Ry Age—Jan. 5, 1906. No. 74208.

Proposed Solutions of the Railway Rate Problem. H. T. Newcomb. Abstract of a paper presented at meeting of the Am. Association for the Advancement of Science. A discussion of certain principles in connection with the measures proposed for new legislation. 5500 w. Ry Age—Jan. 5, 1906. No. 74207.

Tonnage.

Daily Train Tonnage Chart—C. & E. I. Gives a chart devised by H. I. Miller which gives for instant inspection all the essential information relative to one day's northward freight train movements, with explanation. 700 w. R R Gaz—Vol. XL, No. 4. No. 74579.

Traffic.

The Development of American Railway Traffic (Die Entwicklung des Amerikanischen Eisenbahnwesens). Bruno Simmersbach. A tabulated study of the growth in mileage and traffic of American railroads, with data concerning costs and operation. 4500 w. Glasers Annalen—Jan. 1, 1906. No. 74616 D.

MISCELLANY.

Ash Handling.

Economical Ash Handling. Views and description of the ash-pit designed and patented by C. R. Ord, two having been in operation for over two years have given perfect satisfaction. 1100 w. Ry & Loc Engng—Jan., 1906. No. 74201 C.

Colonial Railways.

Colonial Government Railways. Discusses the conditions governing the extension and management of railways constructed and worked by a State, with special reference to the Australian Colonies. 1200 w. Engng.—Jan. 19, 1906. No. 74746 A.

Gulf Routes.

Railroad Routes to the Gulf. Editorial discussion of the changes to secure gulf connection, and the advantages and disadvantages of gulf ports, especially in regard to the export of grain. 2500 w. R R Gaz—Vol. XL. No. 3. No. 74452.

Legislation.

Recent State Railroad Commission Legislation. Frank Haigh Dixon. Abstract of an article in the Pol Sci Qr. Considers the acts passed in Washington, Indiana, Kansas, and Wisconsin, providing for the creation of state railroad commissions. 3000 w. R R Gaz.—Vol. XL. No. 4. No. 74581.

Review.

A Review of the Railroad Year. An interesting general review of the progress, the construction, electrification, etc. 2500 w. R R Gaz—Vol XL, No. 1. No. 74210.

Statistics.

Length and Cost of Construction of the Railways of the World (Longuer et Prix d'Establissement des Chemins de Fer). A tabulated view of the mileage, territory and population served, and general cost of the railways of the world at the close of 1903. 2000 w. Génie Civil—Dec. 16, 1905. No. 74626 D.

Railroad Statistics. A. A. Goodchild. Read at Dec. meeting of the Canadian Ry. Club. Outlines the great number of incidentals necessarily included in railway management, discussing ways of bettering present methods, and making the statistics more valuable. 5000 w. R R Gaz—Vol. XL, No. 3. No. 74454.

Supplies.

The True Perspective of the Supply Department. George Yeomans, A short paper with lengthy discussion on the importance of this department of railways. 1600 w. Pro W Ry Club—Dec. 19, 1905. No. 74350 C.

STREET AND ELECTRIC RAILWAYS

STREET AND ELECTRIC RAILWAYS.

Belfast.

The Belfast Tramways Undertaking. Illustrated detailed description. 2300 w. Elec Rev. Lond—Jan. 19, 1906. No. 74738 A.

Boston Subway.

Washington Street Subway in Boston. An illustrated description, as given in the report of the Boston Transit Commission. 4000 w. R R Gaz—Vol. XL. No. 4. No. 74582.

Brakes.

Brakes. A. L. C. Fell. Read before the Tramways & Light Rys. Assn. A discussion of the question of brakes in construction with tramcars, considering the results thus far obtained. 3800 w. Elec Engr, Lond—Jan. 12, 1906. Serial. 1st part. No. 74511 A.

Buenos Aires.

Buenos Aires Electric Tramways. Dr. Alfred Gradenwitz. Illustrates and describes the electrification and extension of the tramway system. 2500 w. Elec Rev, N. Y.—Jan. 27, 1906. No. 74726.

Electric Railways.

Electric Railway Engineering. F. E. Wynne. The first of a series of articles based on a course of lectures delivered by Mr. Clarence Renshaw dealing with the general principles relating to the operation of cars or trains. 3300 w. Elec Jour—Jan., 1906. Serial. 1st part. No. 74536.

Technical Considerations in Electric Railway Engineering. F. W. Carter. Deals in a general way with the technical side of the electrification problem, giving details of the methods employed in investigating the engineering features of the electrical system. 12300 w. Inst of Elec Engrs—Jan. 25, 1906. No. 74880 D.

The Railway in 1905. Dr. Louis Bell. A review of the year, noting the progress, the most important issue being the advance toward alternating current traction. 1800 w. Elec. Rev., N. Y.—Jan. 13, 1906. No. 74429.

Falkirk.

The Falkirk Tramways. Illustrated description of a new line in Scotland. 1200 w. Elec Rev., Lond—Dec. 22, 1905. No. 74142 A.

Fares.

The Canadian System of Collecting Fares. Includes I: Collecting and Handling Fares on the Toronto Railway, by R. T. Clark; II. Handling Fares on the Montreal Street Railway, by H. E. Smith; and Fare Collecting, by D. McDonald. Also editorial. Ills. 6000 w. St Ry Jour—Jan 27, 1906. No. 74722 C.

Hanger Bolts.

The Preservation of Hanger Bolts on Electric Tramways. Robert N. Tweedy. Gives an account of failure of insulated hanger bolts, and the remedy. 1100 w. Elec Rev., Lond.—Dec. 29, 1905. No. 74288 A.

High Speed.

High Speed Electric Railroads. Henry G. Morris. Discusses some of the conditions governing steam and electric railway practice in the United States, and the present speed limitations; reviews facts developed in the German experiments, and presents the "Motor cycle Railway" for consideration. 6800 w. Pro Engrs. Club of Phila—Jan. 1906. No. 74534 D.

Improvements.

Extensions and Improvements on the Chicago & Milwaukee Electric Railroad. An illustrated article concerning the reconstruction, extensions and improvements on the various divisions of this road during the past year. 3000 w. St. Ry Jour—Jan. 20, 1906. Uo. 74469 C.

Interurban.

The Toledo, Port Clinton & Lake Side Railway. Illustrated detailed description of a line which has opened up territory in northern Ohio, hitherto without adequate transportation facilities. 3700 w. St. Ry. Jour—Dec. 30, 1905. No. 74120 C.

Locomotive.

Electric Locomotive (Ganz System) for the Valtellina Line, Italy. Illustrated detailed description of the new locomotives and information of tests. 2500 w. Ry. Age —Dec. 29, 1905. No. 74097.

20,000-Volt Single-Phase Locomotive for Sweden. Illustration and description of a locomotive supplied by the Siemens-Schuckert Co., weighing 36 tons, and intended to haul goods trains at speeds up to 40 miles per hour. 1400 w. Elect'n., Lond—Jan. 5, 1906. No. 74406 A.

London Subway.

The First London Tramway Subway. Illustrated description of the line from the Strand to Islington. Map and sections, with description of the steel cars for the service. 2000 w. Tram & Ry Wld —Jan. 11, 1906. No. 74741 A.

Losses.

Energy Losses on Tramways. Gives figures derived from undertakings in England, with general remarks. 1500 w. Elec. Rev, Lond.—Jan. 12, 1906. No. 74515 A.

Motor Car.

The Delaware & Hudson Gasoline-Electric Car. An illustration, with account of the trial run of this novel car, which was quite successful. 1500 w. St Ry Jour—Feb. 10, 1906. No. 74926 C.

Philadelphia Subway.

The Lighting System and overhead Construction of the Philadelphia Subway. An illustrated article giving particulars of this work. 800 w. St. Ry. Jour—Dec. 30, 1905. No. 74121 C.

Pittsburg.

The Brunot's Island Power House of the Pittsburg Railways Co. Illustrated detailed description of a large power station and its equipment. 3000 w. Ry & Eng. Rev—Jan. 13, 1906. No. 74377.

Power Plant.

Quincy Point Power Plant of the Old Colony Street Railway Co. Howard S. Knowlton. Illustrated description of one of the largest and most interesting power plants in New England. The generating equipment consists of five 2,000 K. W. Curtis turbo-alternators. 2500 w. Engr. U S A—Jan. 15, 1906. No. 74476 C.

Reconstruction.

Extension and Improvements of the Chicago & Milwaukee Electric Railroad Co. An illustrated account of the work accomplished during the last year, in the reconstruction of this property. 4500 w. St Ry Rev—Jan. 15, 1906. No. 74496 C.

Shops.

New Shops of the Oakland Traction Consolidated and Key Route Systems. Illustrated detailed description of new shops in California and their equipment. 6000 w. St Ry Jour—Feb. 3, 1906. No. 74849 C.

Repair Shop Practices of the Toronto Railway. Illustrated description of these shops and some of the important economies and improvements recently introduced. 3000 w. St Ry Jour—Feb. 10, 1906. No. 74923 C.

Repair Shop Practices of the Montreal Street Railway. An illustrated article dealing with practices and devices in shops having a wider range of work than is usually customary. 2800 w. St Ry Jour—Jan. 27, 1906. No. 74723 C.

Signaling.

Automatic Signaling on the District Railway. A short description of the system and its working. 1000 w. Engr, Lond. Jan. 19, 1906. No. 74754 A.

Singapore.

Electric Tramways in Singapore. Illustrated description of the recently completed electric railway system. Among its special features is the employment of narrow gage and of welded rails. 1800 w. St. Ry Jour—Jan 27, 1906. No. 74724 C.

Single-Phase.

Single-Phase Railway in Paris. P. Letheule. Brief illustrated description of single-phase traction with motors of the Latour type. 500 w. St Ry Jour—Feb. 10, 1906. No. 74925 C.

Electrical Equipment for the Sarnia Tunnel, Grand Trunk Railway. Illustrated description of an electrical installation to operate freight and passenger trains through the tunnel that connects the American and Canadian divisions, using the single-phase alternating current system. 2800 w. Ry. & Engng Rev.—Jan. 13, 1906. No.74374.

Single-Phase Electric Locomotives and Power Equipment of the St. Clair Tunnel Company. Illustrated detailed description, with general information. 2300 w. R R Gaz—Vol. XL. No. 3. No. 74455.

Single-Phase Locomotive for 20,000 Volts (Einphasenlokomotive für 20,000 Volt). Illustration and general description of the locomotive built for the Swedish State Railway. 1800 w. Elektrotechnik und Maschinenbau—Jan. 1, 1906. No. 74660 D.

Single-Phase Railway Motors. Friedrich Erichberg. Describes the system of the Allgemeine Elektricitäts-Gesellschaft, and states some of its advantages. 2400 w. Elec Engr, Lond—Dec, 22, 1905. No. 74140 A.

The Stubai Valley Railway. Egon E. Seefehlner, in *Elektrische Bahnen und Betriebe.* Illustrated description of the first line equipped for working with single-phase alternating current of high tension and frequency, which has been in satisfactory operation for 15 months. 3000 w. Elec Engr., Lond—Dec. 29, 1905. Serial. 1st part. No. 74285 A.

The Use of Alternating Current for Heavy Railway Service. B. G. Lamme. A discussion of systems that have been developed, which are applicable to heavy service, considering the merits of the single-phase system with commutator type motors, the cost of such a system, etc. 7500 w. St Ry Jour—Jan. 6, 1906. No. 74228 C.

See also Electrical Engineering motors.

Sub-Stations.

Some Considerations Determining the Location of Electric Railway Sub-Stations. C. W. Ricker. Outlines a general method for determining the number and location of sub-stations. 1800 w. Am Inst of Elec Engrs—Dec., 1905. Serial. 1st part. No. 74184 D.

The Relation of Railway Sub-Station Design to its Operation. Sydney W. Ashe. Considers only sub-stations in which high-tension alternating current is received and converted into low-tension direct current. Discusses factors of importance in securing reliability of service. 4000 w. Ills. Am. Inst of Elec Engs. —Dec., 1905. No. 74183 D.

Subways.

Projected Subway Lines in Greater New York. S. D. V. Burr. Discusses the proposed additions to the present subway system, which include nineteen routes. 4500 w. Ir Age—Feb. 1, 1906. No. 74787.

Superposition.

The Work of Superposing Three Lines of the Metropolitan Railway of Paris, at the Place de l'Opera. R. Bonnin. Describes the work of superposition of three lines crossing at the Place de l'Opera. Ills. 1500 w. Eng News—Feb. 1, 1906. No. 74809.

Surface Contact.

The Lincoln Electric Tramways. Short illustrated description of the G. B. surface-contact system, and its operation. 1500 w w. Elec Engr, Lond—Jan. 12, 1906. No. 74509 A.

Switches.

Throwing Devices for Tongue Switches. T. A. Gerlach. Points out the various cases where throwing devices should be used, and describes and illustrates some of the devices, discussing their proper construction. 1500 w. St Ry Rev—Jan. 15, 1906. No. 74495 C.

Tracks.

Bonding and Other Track Improvements on the Calumet Electric Railway. Illustrates and describes the method of cast-welding rail joints in use on this electric railway, and some interesting reconstruction work. 1200 w. St Ry Jour —Feb. 10, 1906. No. 74924 C.

Trucks.

Improvements in Trucks. Elmer E. Cook. Abstract of paper and discussion before the Tramways & Light Rys. Assoc. Calls attention to defects due to bad fitting, and considers the radial truck the greatest recent improvement. Ills. 2000 w. Elect'n, Lond—Dec. 22, 1905. No. 74143 A.

Tunnels.

See Civil Engineering, Construction.

Ventilation.

The Ventilation of the Baker-Street and Waterloo Railway. G. Rosenbusch. Outlines the construction and mode of operation of these tube railways, and illustrates and describes the means adopted to improve the ventilation. 2500 w. Engng.—Dec. 22, 1905. No. 74149 A.

Wisconsin.

Reconstruction Work of the Madison & Interurban Traction Co. Illustrated description of a city system that has been in operation 20 years, and has practically been rebuilt during the past summer. 2400 w. St Ry Rev—Jan. 15, 1906. No. 74494 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w*. New York.
American Electrician. *m*. New York.
Am. Engineer and R. R. Journal. *m*. New York.
American Jl. of Science. *m*. New Haven, U.S.A.
American Machinist. *w*. New York.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w*. Rome.
Architect. *w*. London.
Architectural Record. *m*. New York.
Architectural Review. *s-q*. Boston.
Architect's and Builder's Magazine. *m*. New York.
Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *m*. New York.
Automobile Magazine. *m*. New York.
Automotor Journal. *w*. London.
Beton und Eisen. *qr*. Vienna.
Boiler Maker. *m*. New York.
Brit. Columbia Mining Rec. *m*. Victoria, B. C.
Builder. *w*. London.
Bull. Am. Iron and Steel Asso. *w*. Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bull. Soc. Int. d Electriciens. *m*. Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m*. Lawrence.
Bull. Int. Railway Congress. *m*. Brussels.
California Jour. of Tech. *m*. Berkeley, Cal.
Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *m*. Toronto and Montreal.
Canadian Mining Review. *m*. Montreal.
Cassier's Magazine. *m*. New York and London.
Cement. *b-m*. New York.
Cement Age. *m*. New York.
Central Station. *m*. New York.

Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad.des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingeniería. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe,U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Gazetteer.

A Complete Pronouncing Gazetteer or Geographical Dictionary of the World. Edited by Angelo Heilprin and Louis Heilprin. Size, 11 in. by 8 in.; pp. x, 2,053. Price, $10.00. Philadelphia and London: J. B. Lippincott Company.

Lippincott's Gazetteer has been before the public for half a century, the first edition having been issued in 1855, and through succeeding editions it has maintained during that period its high reputation as a standard work of geographical reference. The present edition, however, is practically a new work, based upon the framework of its predecessor, and retaining the system of pronunciation prepared by the late Dr. Joseph Thomas for the earlier work, but being otherwise entirely rewritten and edited by the eminent geographers whose names appear on the title page.

It is manifestly impossible to give an adequate notice of such a monumental work within the limits of space here available, but it may be practicable to note some of the relations of such a volume to the work of the engineer. Thus, in its pages will be found valuable and recent information concerning the topography of many countries, corrected mountain altitudes, changes which have been made in portions of the earth by reason of engineering operations, and data relating to projected works. Under the title of Panama, there is given, in condensed but clear form, data concerning the climatology of the isthmus, as well as the general topography and geology of the region.

Many places which have come into recent notice by reason of their relation to hydro-electric stations, irrigation works, or other engineering associations, are found in their proper places, although not generally noticed in publications of this kind, while an active use of the gazetteer for the verification of references in the technical periodical press of Europe and America has failed to reveal any error worthy of note or any material lack of fulness.

The work has apparently been brought closely down to date, including the conclusion of the treaty of peace between Russia and Japan, the results of the British expedition into Tibet, and the most recent arctic and antarctic expeditions.

The editors state that the gazetteer is especially complete in references relating to the United States and Canada, which is doubtless correct, but a continual reference to the work for places of varying importance in other parts of the world show a completeness in all respects which is most satisfactory and commendable.

An interesting feature in the gazetteer is the information which it contains as to the mineral resources of the various countries described. The deposits of gold, copper, silver, iron-ore, nickel and coal, as well as of petroleum and other mineral riches, are fully indicated, and in general the natural resources of the different regions of the earth, as well as the usual information concerning population, political importance and manufacturing eminence, are fully recorded. The gazetteer thus constitutes a work of reference of daily value in the library of the engineer, as well as the general reader and writer, one of the books which must be had if one would maintain a reputation for accuracy and reliability in matters of daily comment.

Cements.

Cements, Limes, and Plasters. By Edwin C. Eckel, C. E. Size, 9 in. by 6 in.; pp. xxxiv, 710. Price, $6.00. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

Among the materials of construction used by the engineers at the present time there is little doubt that cement and its associated products stands second only to iron and steel. Masonry, either of stone or brickwork, is rapidly being modified into an associate of structural steel in the form of reinforced concrete, and there is every reason to believe that steel and cement, united in proportion and arrangement as may be determined by engineering precedent and computation, will be the building materials of the immediate future.

From his position on the United States Geological Survey, as well as by reason of his own personal acquirements, Mr. Eckel is eminently fitted to collate and discuss the questions relating to the preparation and uses of cements, mortars, and plasters, and his work represents the results of painstaking effort, in connection with exceptional opportunities to obtain the latest technical information upon the subject.

Although sufficient space is given to the general chemical and physical principles which underlie the preparation and uses of cements, the work gives prominence to the discussion of practical methods of manufacturing the products, as at present employed, with details as to labor, power, and costs, this rendering the book of value to the manufacturer. The data and results included in papers published in European and American engineering journals, many of which are difficult of access, and written in foreign languages, are here gathered together and abstracted, so that the reader is placed in possession of much information not otherwise readily accessible.

The book contains many tables, diagrams and maps, and is fully illustrated.

BOOKS RECEIVED.

L'Incendie, ses causes, sa prevention, son extinction. Par Félicien Michotte. Price, 15 francs. Paris: Vve. Ch. Dunod.

Physics. By Charles Riborg Mann and George Ransom Twiss. Price, $1.25. Chicago: Scott, Foresman & Co.

Hydraulic Power Engineering. By G. Croydon Marks. Price, $3.50. New York: D. Van Nostrand Co. London: Crosby Lockwood and Son.

Theory of Structures and Strength of Materials. By Henry T. Bovey, F. R. S. Fourth Edition. Price, $7.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Radio-Activity. By E. Rutherford, F. R. S. Second Edition. Price, 12s. 6d., $4.00. Cambridge: The University Press. New York: The Macmillan Company.

The Design and Construction of Metallic Bridges. By William H. Burr and Myron S. Falk. Price, $5.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Advanced Mechanical Drawing. By Alpha Pierce Jamison. Price, $2.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Machine Shop Tools and Methods. By W. S. Leonard. Price, $4.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Principles of Electrical Power. By A. H. Bate. Price, 4s. 6d. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain.

Wireless Telegraphy. By A. Frederick Collins. Price, $3.00. New York: McGraw Publishing Company.

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